CALIBRATION OF PRIORITY ANALYSIS MODEL FOR HIGHWAY IMPROVEMENT PROJECTS

A THESIS

Presented to

The Faculty of the Division of Graduate Studies and Research

By

Florence Lightfoot Breen, Jr.

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Civil Engineering

Georgia Institute of Technology

June 1975

CALIBRATION OF PRIORITY ANALYSIS MODEL

FOR HIGHWAY IMPROVEMENT PROJECTS

Approved:

Dr. D. O. Covault, Chairman

Dr. P. S. Jones

Dr. P. H. Wright

Date approved by Chairman August 6, 1975

ACKNOWLEDGMENTS

The author wishes to thank the many employees of the Georgia Department of Transportation who assisted in this work, and Mr. King K. Mak whose earlier work defined the model. A special thanks to my advisors for their efforts with particular appreciation to Dr. Donald O. Covault for his patience and guidance.

TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Purpose of Study

The purpose of this study was to reduce and standardize data used to evaluate and rank transportation improvement projects. It is the second of a two-phase study. In the first phase, the procedural model was developed. This phase refines the model by quantifying and standardizing the data to be used. The product is an implementable computer program which ranks projects in priority order.

The Problem

Definition of Problem

Ten billion dollars is required to fill the estimated highway needs in Georgia for the period 1973-1993.[1] Faced with an increased responsibility for other transportation modes, a highway trust fund no longer earmarked for highways and declining revenues resulting from energy shortages, it must be assumed that sufficient resources to fill all the proposed transportation needs of the State will not be available. Therefore, evaluating proposed improvements as investments is becoming crucial.

The current ranking of transportation improvement projects is not uniform. Data used to justify needs has not been reduced or standardized for project comparison by computer. The present method is, therefore, time consuming and costly. Furthermore, priorities cannot consistently be verified.

History of Problem

It was not until the Hayden-Cartwright Act of 1934[2] that quantifiable planning values were necessary for project implementation. Needed projects were constructed, but on occasions transportation investments were not justified in the general public interest.

Post World War II brought a great boom to the highway construction industry. The benefit/cost ratio became the prime determining factor in project priority in some states.

The 1960's saw the end of the benefit/cost ratio as the sole determining factor for project justification. Many new parameters were considered. Such values as sufficiency indices, volume capacity ratios, and levels of service became prominent factors for consideration.

The Federal Government under Lyndon Johnson initiated a planning-programming and budgeting system. This system imposed strict requirements on states for federal funding. In FY 1969, the Department lost 14.5 million dollars[3] by not meeting preconstruction schedule requirements. This forced an increased emphasis on meeting these commitments and brought into being the programming process.

As early as 1963 the Georgia Department of Transportation attempted to schedule its operations. However, the first serious efforts began in 1970 with the designation of a Project Control Engineer. This signaled the advent of contemporary management theory in the Department. The decision to incorporate an efficiency model into the work process was a common undertaking in the country, and was the rule rather than the exception.

The planning process had the responsibility of identifying what needed to be done. The natural follow-up was to define this need within practical time constraints and anticipated revenues. A further complication was the statutory limitation imposed on program funding. The funding for each administrative or functional category was regulated by State and Federal legislation. Hypothetically, if a program on the Federal-aid primary system was authorized for ten million dollars, and a program on the Federal-aid secondary system was authorized for five million dollars, projects could be constrained as follows:

Federal-Aid Primary Projects	Federal-Aid Secondary Projects
Project 1--Cost 4 million	Project 10--Cost 1 million
Project 6--Cost 2 million	Project 11--Cost 2 million
Project 8--Cost 3 million	Project 15--Cost 2 million
Project 9--Cost 1 million	
Sum = 10 million	Sum = 5 million

Project 1 costing 12 million could not be funded within these constraints. Therefore, a program was acceptable if the projects in each category were producible in the required time period for the authorized amount. The question was, do the projects proposed in each category constitute the highest priority of all projects in that category?

Transportation interest in the 1970's turned to areas impacted by the National Environmental Policy Act of 1969 and the Clean Air Act of 1970. Citizens involvement became an important part of public works and the preconstruction process was altered to accommodate these changes. The public not only demanded to be involved in the process, but asked that previously intimate affairs of transportation be exposed to public scrutiny. This led to the beginnings of the formulation of a methodology for a "Priority Array for Ranking of Transportation Improvements

Projects" in August of 1973 for the Georgia Department of Transportation.[4] This work examined the state of the art as well as proposed a solution by describing a model for a quantifiable evaluation of project priority by category.

Objectives of the Study

The objectives of this study are to test and calibrate the priority analysis model and, from it, to develop an implementable computer program which ranks projects in priority order. To accomplish these objectives requires attainment of the following subobjectives.

1. Establish a Delphi group from which valid and reliable testing and calibration of the model can be made.
2. Increase the validity and reliability of the model by refining the normalizing index.
3. Increase the validity and reliability of the model by refining the weight factors.
4. Refine the model so that it is workable.
5. Develop a computer program for implementing the refined model.

Scope of the Study

Phase I, The Model

The priority analysis model is a procedure through which projects can be ranked by their relative value. It is structured to allow policy makers to place weights on those value determinations which influence judgment. Categories of information are grouped by parameters. Basically, the model approach assigns an overall score to each project by summing the product of individual parameter ratings and their relative weights, expressed mathematically:

$$S = \frac{\sum_{i=1}^{p} (W_i \times R_i)}{\sum_{i=1}^{p} W_i}$$

S = overall score or rating of project

$\sum_{i=1}^{p}$ = summation of evaluating parameters from 1 to p

p = number of evaluating parameters

W_i = weight factor of parameter i

R_i = individual score of evaluating parameter i

$$R_i = \frac{\sum_{j=1}^{n} (r_j \times w_j)}{\sum_{j=1}^{n} w_j}$$

n = number of parameter factors within each parameter weight i

w_j = weight of parameter factor j within parameter i

r_j = rating of parameter factor j within parameter i

(See Appendix C)

The application of the model can be viewed within the following framework:

1. Highway improvement projects are categorized according to their functional classification and improvement types so

that they may be compared under compatible sets of parameters;

2. The evaluating parameters pertinent to each category under consideration are identified;
3. The relative importance of the evaluating parameters is determined and expressed through a set of weighting factors;
4. The rating of each parameter is derived through objective and analytical methods where possible, otherwise through subjective judgments, for each project in each category; and
5. The overall rating of each project is then derived by multiplying each parameter rating (Step 4) by its weighting factors (Step 3). Priorities for each category are determined by summing the products for all parameters.

A schematic of the proposed priority analysis procedure is as shown in Figure 1.

<u>Phase II, The Testing and Calibration Process</u>

Phase II is the primary subject of this report. It was undertaken to refine, test, and calibrate the model by quantifying and standardizing the data used. The calibration and testing process applied the Delphi Technique to identify a score for randomly selected projects. (The Delphi Technique is a method of gaining consensus through expert opinion.)[5,6,7] The sample projects used were selected from projects identified in the Georgia Department of Transportation's Five Year Work Program.[8]

The Delphi Technique was first conceived in the early 1960's by two research scientists at the RAND Corporation as a means of pooling expert opinions. Extensive experiments were carried out to test its

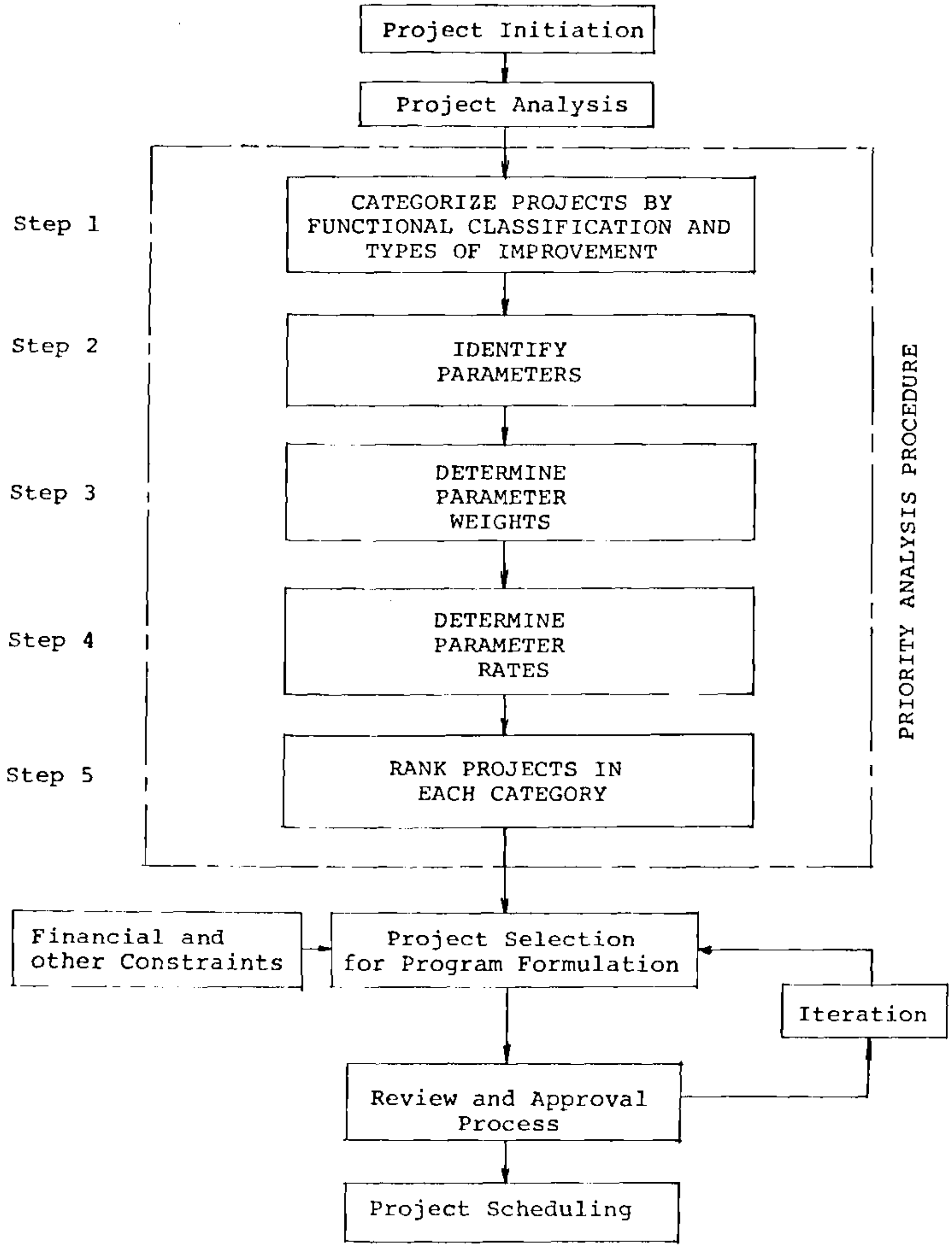


Figure 1. Schematic Diagram of Priority Analysis Procedure

validity with promising results. The Delphi Technique has since been extended and improved and found successful applications in areas such as long-range technological forecasting, value judgments, evaluation of corporate and policy planning by public agencies.

The Delphi Technique is a process for the controlled elicitation of group opinion by an iterative use of questionnaires with a selective feedback of earlier group responses as an informational input for later reference by group members. It has the following unique, distinctive features:

1. Expert opinion;
2. Group response with anonymity; and
3. Iterative process with controlled feedback.

Once the Delphi Technique arrived at a priority value for the sample projects, the model scores were then compared to the Delphi scores. Adjustments were then made by normalization and by varying parameter weights to calibrate the model.

A schematic diagram of the testing and calibration process for the priority analysis procedure is as shown in Figure 2. The specific steps involved were to (a) determine the categories of projects to be tested; (b) pair the categories selected; (c) select and refine parameters to be used in the model; (d) determine the sample size; (e) organize the Delphi (expert) group for calibration; and, (f) rank the projects for testing and calibration.

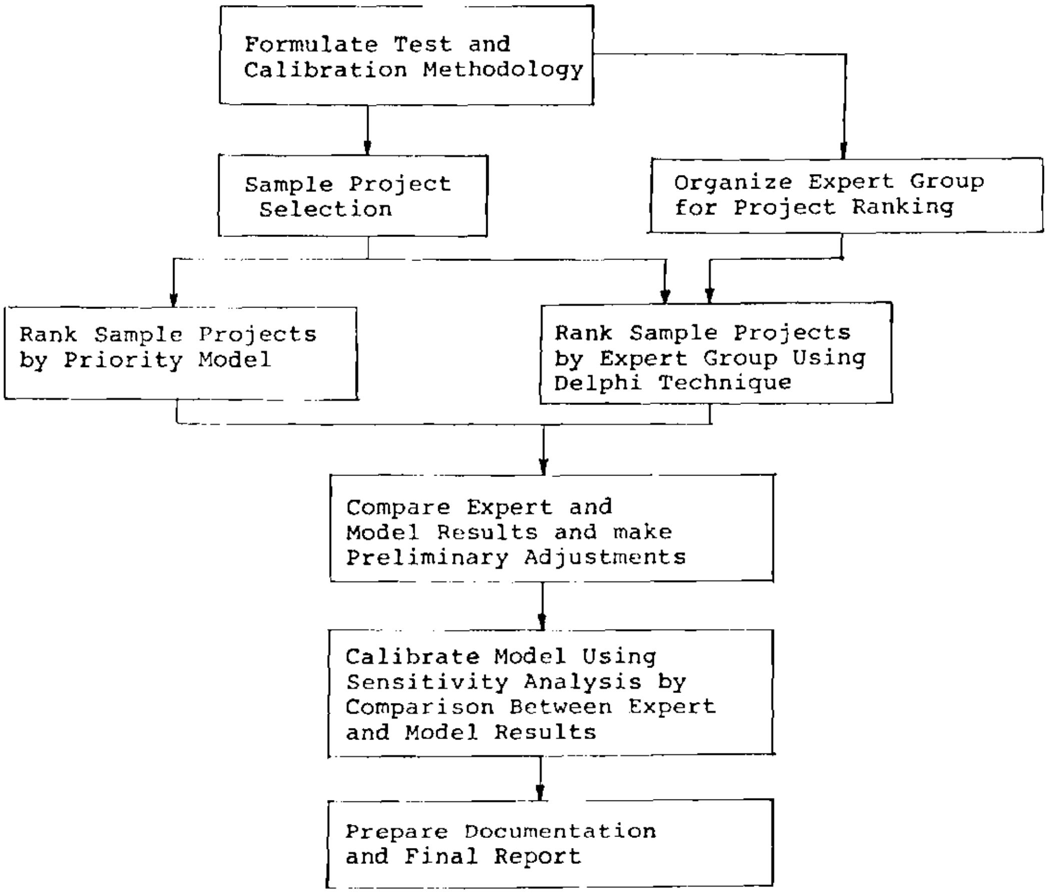


Figure 2. Schematic Diagram of Testing and Calibration Process

CHAPTER II

PROCEDURE USED FOR PREPARING THE MODEL FOR TESTING AND CALIBRATION

Determining the Categories of Projects to be Tested

The first step of the proposed procedure was to segregate the improvement projects into categories by their functional classification and improvement types. The categorization of improvements permits the projects to be evaluated under different but compatible sets of criteria. In addition, categorization provides a basis for legislative and administrative directives in terms of resource allocation, fund appropriation, policymaking and system priorities.

The functional categories used for the priority procedure are:

Interstate
Rural Arterials
Urban Arterials
Rural Collectors
Urban Collectors
Local Access

It was felt that the preceding could generally fit any highway functional classification.

The categorization of improvement type was broken into the following seven groups:

New Construction
Reconstruction and Upgrading
Minor Upgrading
Structures
Safety Improvements
Traffic Engineering Improvements
Special Projects

Table 1 gives a detailed description of each type improvement.

Pairing of the Categories Selected

Examination of each of the six functional classifications with each improvement type in the calibration process was practically impossible. This would have necessitated investigation of a possible forty-two categories of projects. Therefore, it was decided to randomly pair improvement types and functional classifications thereby limiting the number of categories to be used in the calibration.

As new construction on the Interstate System has become the focal point of discussion and these projects are well known, a decision was made that this pairing between improvement type and functional class be exempt from the random pairing process. Interstate and new construction were paired and this improvement type and functional class were eliminated from the pairing process.

It was also concluded that the programming process at the present time should consider special projects priorities subjectively. Therefore, the special projects type of improvement was not considered in the model.

The random pairing resulted in the following:

Local Routes--Safety Improvements
Rural Arterials--Minor Upgradings
Urban Arterials--Traffic Engineering Improvements
Urban Collectors--Reconstruction and Major Upgradings
Rural Collectors--Structures
Interstates--New Construction (arbitrarily selected)

Selection and Refinement of Parameters to be Used in the Model

The evaluating parameters developed in the model measure the critical impacts of all categories of highway projects without requiring

Table 1. Types of Improvements

1. New highway construction

   New highway construction and related engineering work.

2. Reconstruction and major highway upgrading

   Reconstruction, relocation, realignment, additional lane(s), and widening.

3. Minor highway upgrading

   Resurfacing, repaving, grading, drainage, paving shoulders and surface treatment.

4. Structures, new and replacements

   Bridge structures, culverts, sign support structures and special structures.

5. Safety improvements

   Safety projects, pedestrian overpasses, guardrails, medians, separator and sidewalk constructions, street lighting, roadway separation structures, railroad signals, and crossing markings.

6. Traffic engineering improvements

   TOPICS,* intersection improvements, traffic signals, flash and overhead signing.

7. Special projects**

   Projects that cannot be classified into any of the above improvement types, such as rest area, weighing station, beautification projects, etc.

*Traffic Operations Projects Improving Capacity and Safety

**Special projects will be ranked subjectively.

extensive changes in existing data collection systems. They were identified from existing evaluation procedures with additions to provide adequate coverage of all significant impacts. Table 2 gives a list of the parameters and their factors.

Appendix A lists the parameters along with the corresponding departmental office responsible for evaluating and rating each factor. Appendix B shows the criteria and scales used to evaluate each factor.

Determining the Sample Size

The current Five Year Construction Work Program[8] contains more than 1,500 projects and the practicality of examining this number would preclude realistic time constraints for calibration. The six categories of project pairing improvement type and functional classification had to be limited to a reasonable number of projects. It was decided to use ten projects for each pair, comprising a total of sixty projects.

Organizing the Delphi (Expert) Group for Calibration

The objective of organizing the Delphi (expert) group was to arrive at a consensus score for each of the six groups of ten projects. These sixty project Delphi scores would be used to calibrate the model by minimizing the squared differences between these scores and the model scores.

The first assumption was that a broad representation of both staff personnel and project priority policymakers outside the department would be desirable. After considerable discussion, the group was confined to the department staff. The relative ease of assembly of the group, the expertness of the staff on project priority, and the acceptability of staff

Table 2. List of Evaluating Parameters and Component Factors

1. Need Parameter:

   Identified by transportation plan(s);
   Identified by state, regional or local officials;
   Identified by department officials; and,
   Community response or local opinion(s).

2. Physical Deficiency Parameter:

   Structure condition;
   Structure adequacy;
   Pavement condition; and,
   Pavement adequacy.

3. Operational Deficiency Parameter:

   Existing and projected traffic volume;
   Service level--volume/capacity ratio;
   Operating speed or delay factor; and,
   Roadway alignment and geometrics.

4. Safety Deficiency Parameter:

   Accident experience;
   Accident potential; and,
   Roadway alignments and geometrics.

5. Continuity Parameter:

   Continuity with existing highway network;
   Coordination with multi-modal facilities; and,
   Coordination with other highway improvement projects.

6. Benefit/Cost Parameter:

   Benefit/cost ratio--user benefit only.

7. Economic Parameter:

   Conformity with state, regional or local comprehensive and development plan(s);
   Impacts on land value and development;
   Impacts on tax base:
     Commercial activities
     Industrial activities
     Agricultural activities
     Tourism or recreational activities
     Employment
   Impacts on public services.

Table 2. List of Evaluating Parameters and Component Factors (Continued)

8. Social Parameter:

   Displacement of residential and commercial units;
   Impacts on social patterns in affected communities;
   Disruption to communities during construction; and,
   Preservation of historic, religious, and institutional sites.

9. Environmental Parameters:

   Impacts on aesthetics and scenic enhancement;
   Impacts on air pollution;
   Impacts on water pollution;
   Impacts on noise pollution;
   Impacts on physical resources; and,
   Impacts on biological resources.

opinion were strong points for including only department members in the group. The major disadvantage was the lack of universal acceptance of the process. It is hoped that the parameter weights derivation process which did include outside opinion will overcome the disadvantage.

The priority process was guided in the Department by a technical committee to insure an acceptable priority process and to give policy guidance to the study. The group should insure acceptance of the calibration results; and as they are experts in transportation priority selection, it was decided to use the technical committee as the Delphi group. The following persons participated in the experiment:

Drew A. Brown	State Transportation Programming Engineer
Emery S. Horvath	Chief, Bureau of Program Development
Robert C. Kirk	State Transportation Planning Engineer
Wendell Lawing	Asst. State Highway Bridge Engineer--Design
Robert E. Bowling	Chief, Plan Development Bureau
Floyd Hardy	Chief, Environmental Analysis Bureau
Alton G. Wiggers	Asst. State Highway Maintenance Engineer
John T. Kratzer	State Highway Bridge Design Engineer
Wyndald Ethridge	State Highway Road Design Engineer
William D. McCoy	Asst. State Highway Urban Engineer
Kirby D. Hamil	Asst. State Highway Urban Engineer
Archie C. Burnham	State Highway Traffic and Safety Engineer
Don Senkbeil	Asst. State Highway Traffic and Safety Engineer
Jose Nieves	Systems Development Administrator
Robert L. Alston	State Highway Location Engineer
Jack Murphy	Scheduling Engineer--Tennille District

Ranking the Projects for Testing and Calibration

In this step the ten sample projects in each category were subjectively scored by the experts and ranked according to their score. The purpose of this effort was to establish a Delphi standard to compare against the total parameter score from the model. Figure 3 is a completed example of the form used.

Standard information was given on each project to the expert group

The projects were then ranked subjectively. The scores were re-ranked by the expert group until a statistical comparative level was reached. Figures 4 and 5 are examples of the statistical forms used. The underlying assumption of the Delphi technique is that weakly held opinions will move towards the mean of strongly held opinions when reevaluated. It is assumed that the more strongly held opinions are closer to the truth. It was emphasized that first reactions were the most important.

The sample projects were next ranked in each category by the model. Appendix C gives an example of the priority model for one of the sample projects. The histogram in Figure 5 indicates the dispersion in first round values, and the example in Appendix C illustrates the rapid convergence in subsequent iterations.

2nd ROUND SCORE SHEET

Test Group: 3 Rater: Kirby D. Hamil

Functional Class: Rural Arterial Type of Work: Minor Upgrading

		Rank									
		1	2	3	4	5	6	7	8	9	10
____ Round	Project	J	B	G	A	C	H	I	E	D	F
	Score	90	85	70	60	55	45	40	30	20	10

Figure 3. Example of a Delphi Score Sheet

___1st___ ROUND FEEDBACK SHEET

Test Group: ___3___

Functional Class: ___Rural Arterial___ Type of Work: ___Minor Upgrading___

			Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9	Rank 10
____ Round	Project		J	B	G	A	C	I	E	H	D	F
		Mode	1	2	3	5	6	8	8	5,7,&9	9	10
	Score	1st Quartile	75.0	50.0	60.0	50.0	45.0	37.5	35.0	30.0	23.3	14.0
		Mean	81.3	68.3	66.4	59.8	56.1	55.3	45.3	44.6	38.6	26.5
		3rd Quartile	95.0	86.7	84.0	75.0	75.0	80.0	65.0	66.7	55.0	45.0

Figure 4. Example of a First Round Feedback Sheet

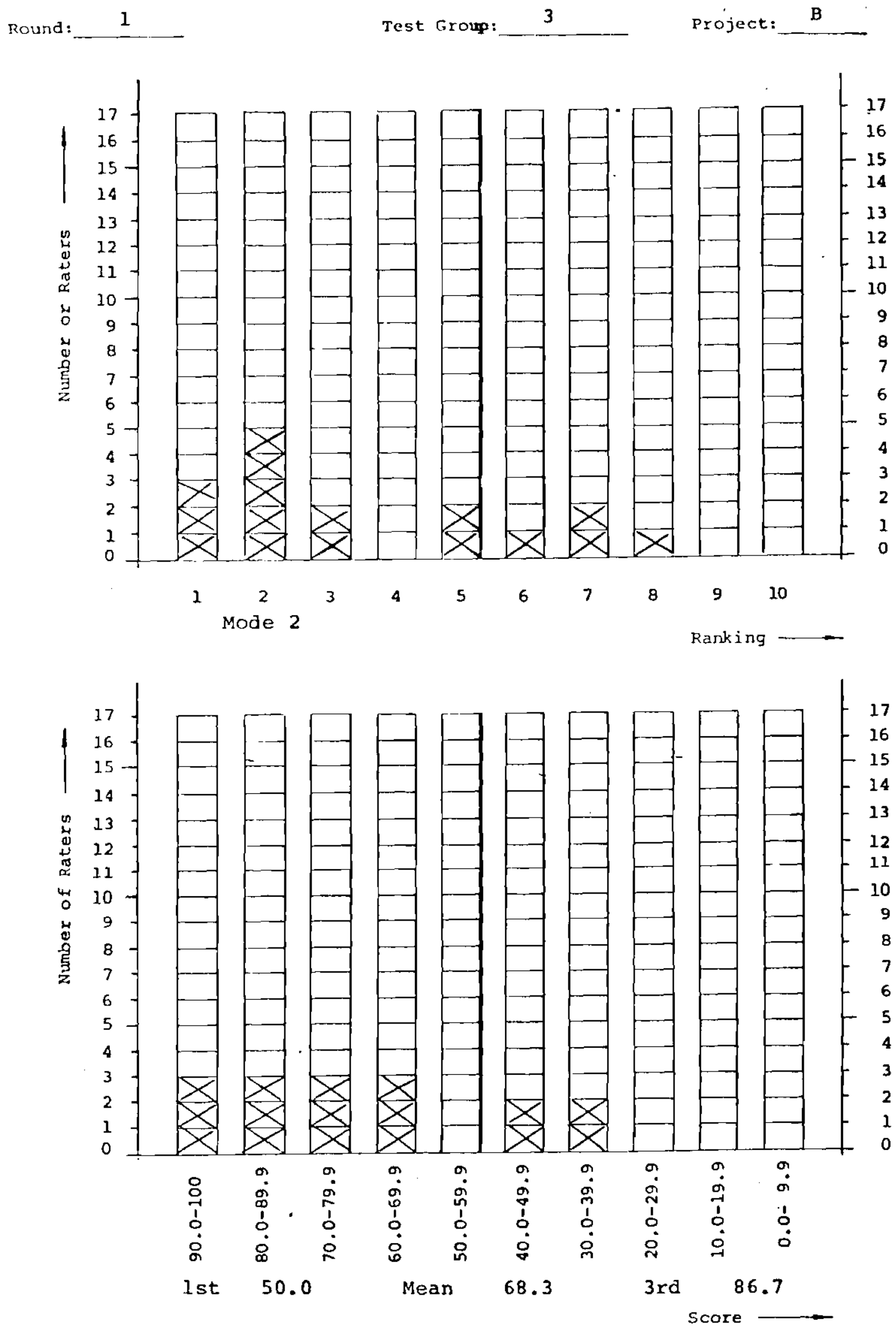


Figure 5. Example of a First Round Histogram
Rural Arterial

CHAPTER III

CALIBRATING AND TESTING THE MODEL

The calibration and testing process compared the model scores to the Delphi scores. The squared differences were minimized thereby standardizing the model for use. Two major aspects, the parameter weights and the normalizing index were adjusted. The first adjustments used the normalizing index.

Parameter Weights

This calibration process involved adjusting the model parameter weights until the difference between the Delphi score and model scores quantity squared was minimized. (See Table 3.)

Table 3. Calibration Objective Function

Project	Delphi Score	Model Score	Difference
1	P_1^D	P_1^M	$D_1 = P_1^D - P_1^M$
2	P_2^D	P_2^M	$D_2 = P_2^D - P_2^M$
3	P_3^D	P_3^M	$D_3 = P_3^D - P_3^M$
4	P_4^D	P_4^M	$D_4 = P_4^D - P_4^M$
N	P_N^D	P_N^M	$D_N = P_N^D - P_N^M$

Objective

$$\text{Minimize} \sum_{i=1}^{N} (D_i)^2 = Z$$

The Normalizing Index (N. I.)

The normalizing index is a formula to help minimize the squared differences between the model and the Delphi scores by giving greater sensitivity to traffic volume and project cost. It arrives at a value to be multiplied by the project score to obtain a final score. Initially, it was as follows:

$$\text{N.I.} = 1 + \text{Log}\left(\frac{\text{traffic volume x p}}{\text{project cost}}\right)^{q}$$

where the traffic volume is the average annual daily traffic; project cost is the total cost in dollars; and p and q are arbitrarily assigned constants. Assumed values of p ranged from 0.1 to 1,000 and values of q were to range from 0.25 to 4. The values of p and q were varied to minimize the squared differences between Delphi and model scores. The squared differences were plotted against the values of p's and q's. The p's and q's which gave the smallest squared difference were selected for each category. (See Figure 6.)

Revised Normalizing Index

When the foregoing procedure was applied, the normalizing index did not vary sufficiently to gain usable results. Wide changes in p did not yield squared differences which approached a low point. The original normalizing index was not sensitive enough to accomplish desired results.

For this reason, the normalizing index was changed to the following:

$$\text{N.I.} = q \times e^{\left(\frac{\text{traffic volume}}{\text{project cost}} \times p\right)}$$

The modified version gave values producing desired results. Modest changes in p and q yielded curves with easily identified minimun squared difference values. Using a normalizing index sensitive to average annual daily traffic and cost was continued, and the sensitivity was increased to yield usable results.

The curves of p plotted against the squared differences for each category indicated the relationship to be roughly parabolic. The p and q values were selected that gave the lowest squared differences.

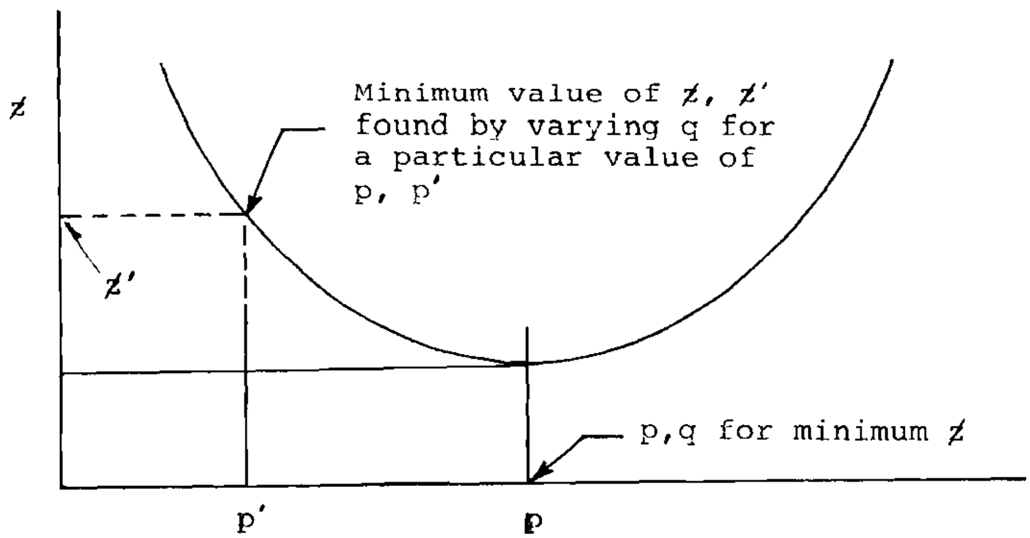


Figure 6. p, q, Ƶ Relationship.

CHAPTER IV

RESULTS AND CONCLUSIONS

Delphi Experiment

Prior to the Delphi experiment it was felt that the evaluation of the Interstate new construction category would be fairly uniform and that dispersions in other categories would be broader. This proved to be true except that the deviations for the other functional classes and improvement types were broader than anticipated. The dispersion was so great after the first iteration that hopes were dim for consensus.

However, the anticipated movement towards consensus was remarkably good and dispersion of opinion quickly closed on each subsequent iteration. Members of the expert group reevaluated their opinions in light of feedback information from the previous iteration. This led to reassessment and rearrangement of personal preferences and emphases, and effectuated a group consensus. It was felt that the Delphi values were excellent.

The Normalizing Index

The revised normalizing index gave values producing desired results so that modest changes in p and q yielded curves with easily identified minimum squared difference values. The basic concept of using a normalizing index that was sensitive to average annual daily traffic and cost was maintained, and the desired sensitivity was increased so that usable results were evidenced. Further work in this area could produce a normalizing index which would be more appropriate than the one currently used in the model.

The curves of p and q plotted against the squared differences indicate that the relationship is roughly parabolic. However, further refinement of the mathematical relationship between the squared differences and p and q should improve its usability. Figure 7 gives the normalizing index selected for each improvement type. The results of the normalizing index did not substantially change the rankings compared to the uncalibrated rankings. The principal value gained from using the normalizing index was to bring the normalized scores within the range of the Delphi scores. Figures 8 through 13 show the results of the normalizing index.

Weight Factors

New Construction--Interstates

Analysis of scores and rankings between the Delphi Group and normalized model scores indicated no significant differences. The only significant improvements that could be made were by lessening social and environmental factors. With the growing importance of these it was decided to keep the weights in this category unchanged.

Reconstruction and Major Upgrading--Urban Collectors

The data for scoring in this category were not what was originally envisioned as acceptable. But, after following the calibration procedures, no appreciable improvement between Delphi scores and model scores, or rankings could be accomplished. Even though the squared differences between Delphi scores and model scores were higher (see Table 4), the weight factors for the model scores were left unchanged.

Improvement Types	p	q	
New Construction	2.62	1.07	$NI = 1.07 \times e^{\left(\frac{\text{traffic volume}}{\text{project cost}}\ (2.62)\right)}$
Reconstruction and Major Highway Upgrading	0.80	1.365	$NI = 1.365 \times e^{\left(\frac{\text{traffic volume}}{\text{project cost}}\ (0.80)\right)}$
Minor Highway Upgrading	0.83	1.28	$NI = 1.28 \times e^{\left(\frac{\text{traffic volume}}{\text{project cost}}\ (0.83)\right)}$
Structures, New and Replacements	10.6	1.328	$NI = 1.328 \times e^{\left(\frac{\text{traffic volume}}{\text{project cost}}\ (10.6)\right)}$
Safety Improvements	0.0	1.270	$NI = 1.270$
Traffic Engineering Improvements	0.0	1.057	$NI = 1.057$

Figure 7. Final Normalizing Index Equations

PROJECT	DELPHI RANKING	DELPHI SCORE	UNCALIBRATED RANKING	UNCALIBRATED SCORE	NORMALIZED RANKING	NORMALIZED SCORE	NORMALIZED INDEX	ADJUSTED WEIGHT FACTOR RANKING	ADJUSTED WEIGHT FACTOR SCORE
A	10	39	10	35	10	38	1.07	10	38
B	9	41	9	38	9	41	1.08	9	41
C	5	73	6	59	6	63	1.07	6	63
D	7	64	7	53	7	57	1.07	7	57
E	4	75	1	84	1	92	1.09	1	92
F	8	52	8	44	8	48	1.08	8	48
G	2	90	4	76	2	86	1.13	2	86
H	3	88	3	76	3	83	1.08	3	83
I	1	92	2	76	4	83	1.08	4	83
J	6	66	5	76	5	82	1.08	5	82

$\not{t} = 849.4 \quad p = 2.62 \quad q = 1.07$

Figure 8. Improvement Type--New Construction

PROJECT	DELPHI RANKING	DELPHI SCORE	UNCALIBRATED RANKING	UNCALIBRATED SCORE	NORMALIZED RANKING	NORMALIZED SCORE	NORMALIZED INDEX	ADJUSTED WEIGHT FACTOR RANKING	ADJUSTED WEIGHT FACTOR SCORE
A	4	77	3	54	3	75	1.39	3	75
B	10	31	10	31	10	42	1.36	10	42
C	6	64	1	57	1	79	1.37	1	79
D	9	42	9	38	9	52	1.38	9	52
E	7	47	8	38	8	59	1.53	8	59
F	8	47	7	44	7	60	1.37	7	60
G	5	70	4	48	4	67	1.38	4	67
H	2	88	5	46	5	65	1.40	5	65
I	1	91	2	56	2	77	1.37	2	77
J	3	81	6	45	6	64	1.42	6	64

$\ell = 1785.0 \quad p = 0.80 \quad q = 1.365$

Figure 9. Improvement Type--Reconstruction and Major Highway Upgrading

PROJECT	DELPHI RANKING	DELPHI SCORE	UNCALIBRATED RANKING	UNCALIBRATED SCORE	NORMALIZED RANKING	NORMALIZED SCORE	NORMALIZED INDEX	ADJUSTED WEIGHT FACTOR RANKING	ADJUSTED WEIGHT FACTOR SCORE
A	4	64	5	45	5	60	1.31	6	59
B	2	77	3	49	4	64	1.30	2	71
C	5	61	2	51	3	65	1.29	4	66
D	9	37	7	42	7	55	1.29	7	52
E	7	44	10	35	10	45	1.28	8	45
F	10	32	8	36	8	47	1.28	9	43
G	3	71	6	45	6	58	1.30	5	61
H	8	44	9	36	9	46	1.28	10	40
I	6	54	4	46	2	66	1.40	3	68
J	1	85	1	52	1	70	1.35	1	79

$\ell = 760.7 \quad p = 0.83 \quad q = 1.28$

Figure 10. Improvement Type--Minor Highway Upgrading

PROJECT	DELPHI RANKING	DELPHI SCORE	UNCALIBRATED RANKING	UNCALIBRATED SCORE	NORMALIZED RANKING	NORMALIZED SCORE	NORMALIZED INDEX	ADJUSTED WEIGHT FACTOR RANKING	ADJUSTED WEIGHT FACTOR SCORE
A	10	43	10	36	10	48	1.34	10	52
B	5	68	4	47	4	63	1.35	5	64.4
C	6	54	8	43	8	60	1.38	8	60
D	9	45	5	47	5	63	1.35	7	61
E	7	54	9	42	9	58	1.38	9	59
F	1	83	6	45	7	61	1.35	3	66
G	2	80	1	55	1	73	1.34	2	76
H	4	73	7	45	6	62	1.40	4	64.6
I	8	48	3	47	3	64	1.35	6	64.1
J	3	76	2	54	2	72	1.34	1	77

$\not{t} = 1044.9 \quad p = 10.6 \quad q = 1.328$

Figure 11. Improvement Type--Structures, New and Replacements

PROJECT	DELPHI RANKING	DELPHI SCORE	UNCALIBRATED RANKING	UNCALIBRATED SCORE	NORMALIZED RANKING	NORMALIZED SCORE	NORMALIZED INDEX	ADJUSTED WEIGHT FACTOR RANKING	ADJUSTED WEIGHT FACTOR SCORE
A	10	36	10	38	10	48	1.27	10	44
B	4	71	6	50	6	64	1.27	4	67
C	1	89	3	53	3	67	1.27	3	68
D	5	64	1	54	1	68	1.27	5	64.9
E	8	51	2	53	2	67	1.27	7	63
F	6	57	9	48	9	60	1.27	8	62
G	7	56	7	50	7	64	1.27	6	64.1
H	9	39	8	48	8	61	1.27	9	55
I	3	79	4	52	4	66	1.27	2	71
J	2	86	5	52	5	66	1.27	1	72

$\not{t} = 1206.7 \quad p = 0.0 \quad q = 1.270$

Figure 12. Improvement Type--Safety Improvements

PROJECT	DELPHI RANKING	DELPHI SCORE	UNCALIBRATED RANKING	UNCALIBRATED SCORE	NORMALIZED RANKING	NORMALIZED SCORE	NORMALIZED INDEX	ADJUSTED WEIGHT FACTOR RANKING	ADJUSTED WEIGHT FACTOR SCORE
A	4	67	10	50	10	53	1.06	8	53
B	5	62	7	54	7	57	1.06	6	63.1
C	2	79	8	53	8	56	1.06	5	63.2
D	9	43	5	56	5	60	1.06	10	48
E	1	87	1	75	1	79	1.06	1	81
F	6	59	2	67	2	71	1.06	4	64
G	3	76	6	56	6	59	1.06	3	65
H	10	38	9	53	9	56	1.06	9	51
I	7	58	3	64	3	67	1.06	2	72
J	8	54	4	59	4	62	1.06	7	62

$\not{t} = 1127.9$ $p = 0.0$ $q = 1.057$

Figure 13. Improvement Type--Traffic Engineering Improvements

Table 4. Summation of the Squared Differences Between the Delphi Scores and the Model Scores for Each Type of Improvement and Each Type of Model Score

Improvement Type	Unadjusted Scores	Normalized Scores	Adjusted Weight Factor Scores
New Construction	1183	850	850
Reconstruction and Major Highway Upgrading	5549	1785	1785
Minor Highway Upgrading	3160	1295	761
Structures, New and Replacements	3800	1320	1044
Safety Improvements	3350	2044	1206
Traffic Engineering Inprovements	2100	2008	1128

Minor Upgrading--Rural Arterials

It was felt in this case that the need, continuity, safety, and the environmental impact had been overstated while the traffic volumes and physical deficiencies were underestimated. Therefore, the parameter changes were as follows:

PARAMETER	REMARK
Need	Decreased by 2.0
Physical deficiency	Kept at same high level
Operational deficiency	Increased by 2.5
Safety deficiency	Increased by 1.9
Continuity	Lowered by 3.0
Benefit/Cost	No change
Economic	Minor change
Social	Minor change
Environmental	Lowered by 2.0 per individual weight and by 1.3 for the parameter

Structures--Rural Collectors

Structural deficiencies or improvements cannot currently be appreciated by planning studies based on need, since this is strictly a maintenance problem. That is, structural distress is found only after the needed improvement becomes obvious by sensory perception. It is after the fact, not planned. Physical deficiencies and safety are the important factors and other factors must not be overemphasized. Therefore, the following changes were made:

PARAMETER	REMARK
Need	Decreased by 2.0
Physical deficiency	Kept at same level
Operational deficiency	Decreased by 1.0
Safety deficiency	Increased by 1.1
Continuity	Decreased by 3.0
Benefit/Cost	No change
Economic	Decreased by 2.0
Social	Slight change
Environmental	No change

Safety Improvements--Local Routes

These improvements are most responsive to accidents both from the standpoint of experience and potential. Physical deficiences and traffic volumes affect safety but are not easily correlated. Alignment, a factor in this category, was altered to reduce its dominance. Continuity and the environment need to be considered, but need to have non-major emphasis in this category. The following changes were considered desirable:

PARAMETER	REMARK
Need	Department officials and community response lowered by 3.0, others lowered by 5.0, with the average lowered by 4.0
Physical deficiency	Lowered by 5.0
Operational deficiency	Safety devices and traffic volume lowered by 1.0, others lowered by 5.0, the average lowered by 4.0
Safety deficiency	Accident experience increased to 9.8, alignment lowered to 3.9.
Continuity	Decreased by 5.0
Benefit/Cost	Lowered by 2.0
Economic	Not applicable
Social	Not applicable
Environmental	Not applicable

Traffic Engineering Improvements--Urban Arterials

The most important factor in Traffic Engineering improvement is the safe traffic flow through intersections. Physical deficiences and continuity parameters do not have major relevance to this type improvement. Likewise neither does the need parameter in the "identified by transportation plan" factor. The following are changes:

PARAMETER	REMARK
Need	Community response decreased by 1.0, others decreased by 5.0. Average decreased by 4.0
Physical deficiency	Decreased by 7.0
Operational deficiency	Average decreased by 3.0. Volume and speed and delay lowered by 2.0, others by 4.0. Parameter 3 remains the second most important parameter
Safety deficiency	Accident experience and potential raised to 9.8. Alignment and geometry raised to 9.2. Parameter average up to 9.6
Continuity	Multi-modal continuity decreased 6.0, others by 5.0
Benefit/Cost	Lowered by 3.0
Economic	Not applicable
Social	Not applicable
Environmental	Not applicable

As can be seen in Table 3, weight changes improved normalized scores for each improvement type except type 1 (new construction) and type 2 (reconstruction and major highway upgrading). Table 5 indicates the convergence of project rankings due to calibration. Except for a small increase in type 1 and no change in type 2, the results are pronounced. The final adjusted weight factors are given in Appendix E.

Figures 8 through 13 give a summary of the results of the test and calibration. Each project is listed showing the results of the normalizing index and the weight adjustment on the scores and ranking.

Summary of Results and Conclusions

The result of this phase of the study was a success. The Delphi experiment ranked and assigned numerical values to projects with reasonable

Table 5. Summation of the Squared Differences Between the Delphi Rankings and the Model Rankings for Each Type of Improvement and Each Type of Model Scores

Improvement Type	Unadjusted Scores	Normalized Scores	Adjusted Weight Factor Scores
New Construction	16	20	20
Reconstruction and Major Highway Upgrading	48	48	48
Minor Highway Upgrading	42	52	28
Structures, New and Replacements	86	92	24
Safety Improvements	80	80	12
Traffic Engineering Improvements	150	150	58

consensus of opinion. Weights were adjusted in the model so that major differences are not evident between the model and Delphi scores. The methodology of calibrating the model will be useful in refining and updating the model and the priority array process. The model was refined, by quantifying and standardizing the data to be used. An implementable computer program has been developed which ranks projects in priority order. It is felt that the model establishes credibility of the method. Decision-makers can guide investments not only by decisions as to resource allocation by functional class, but by setting minimum priority scores before investments. (See computer program in Appendix F.)

However, the results of this effort can be improved upon. Work needs to be done in:

1. Reanalyzing the Normalizing Index.
2. Refining data to be used in ratings.
3. The Delphi process with the possibility of concurrent model calibration with the activities of the Delphi Group, and establishing criteria for the makeup of the Group.
4. Establishing mathematical relationships.

This refinement can be accomplished once more experience is gained through use. One of the immediate problems that must be faced with the model is that of data collection. Standards must be set not only for the collection of data but for the assignment of scores to these values. The planning and programming process must be redefined for the reasons that benefit/cost ratios and environmental values and other details that establish a project's merit must be identified before the project is approved for the Construction Work Program.

APPENDIX A

List of Factors and Corresponding Office
Assigned for Evaluation and Rating of Factor

List of Factors and Corresponding Office(s) assigned for Evaluation and Rating of Factor.

Factor	Evaluating Office
I. NEED PARAMETER	
A. Need as identified by transportation plan(s)	Office of Programming
B. Need as identified by state, regional or local officials	Office of Programming
C. Need as identified by department officials	Office of Programming
D. Community response or local opinion(s)	Office of Planning
II. PHYSICAL DEFICIENCY PARAMETER	
A. Structure condition	Office of Maintenance
B. Structure adequacy	Office of Maintenance
C. Pavement condition	Office of Maintenance
D. Pavement adequacy	Office of Maintenance
III. OPERATIONAL DEFICIENCY PARAMETER	
A. Existing and projected traffic volume	Office of Planning
B. Service level - volume/capacity ratio	Office of Planning
C. Operating speed or delay factor	Office of Traffic Engineering and Safety
D. Roadway alignment and geometrics	Office of Planning
IV. SAFETY DEFICIENCY PARAMETER	
A. Accident experience	Office of Traffic Engineering and Safety
B. Accident potential	Office of Traffic Engineering and and Safety
C. Roadway alignments and geometrics	Office of Traffic Engineering and Safety

Factor	Evaluating Office
V. CONTINUITY PARAMETER	
A. Continuity with existing highway network	Office of Planning
B. Coordination with multi-modal facilities	Office of Public Transportation and Research
C. Coordination with other highway improvement projects	Office of Programming
VI. BENEFIT-COST PARAMETER	
A. Benefit/cost ratio - user benefits only	Office of Planning
VII. ECONOMIC PARAMETER	
A. Conformity with state, regional or local comprehensive and development plan(s)	Office of Planning
B. Impacts on land value and development	Office of Planning
C. Impacts on tax base	Office of Planning
D. Impacts on employment	Office of Planning
E. Impacts on Public Services	Office of Planning
VIII. SOCIAL PARAMETER	
A. Displacement of residential and commercial units	Office of Planning
B. Impacts on social patterns in affected communities	Office of Planning
C. Disruption to communities during construction	Office of Planning
D. Preservation of historic, religious and institutional sites	Office of Planning

Factor	Evaluating Office
IX. ENVIRONMENTAL PARAMETER	
A. Impacts on aesthetics and scenic enhancement	Office of Planning
B. Impacts on air pollution	Office of Planning
C. Impacts on water pollution	Office of Planning
D. Impacts on noise pollution	Office of Planning
E. Impacts on physical resources	Office of Planning
F. Impacts on biological resources	Office of Planning

APPENDIX B

Criteria and Rating Scales for Factor Evaluation

I. NEED PARAMETER*

Factor A. Need as identified by transportation plan(s). -- Office of Programming

Criteria:

(i) Is the project under consideration identified in the most recent transportation study?

(ii) What priority is assigned to project in the study?

(iii) What time period is project assigned in the study?

Scale		
10–8	Identified in transportation plan	High priority, immediate implementation
8–5	Identified in transportation plan	High priority, 1-5 years period
5–3	Identified in transportation plan	Medium priority, 5-10 years period
3–1	Identified in transportation plan	Medium priority, 10-20 years period
1–0	Identified in transportation plan	Low priority, 10-20 years period
0		Not identified in transportation plan

Factor B. Need as identified by state, regional, or local officials. -- Office of Programming.

Criteria:

(i) What priority is assigned to project by local (county or city) officials?

(ii) How urgent does the officials feel about the project on state or regional levels?

(iii) How urgent does the State Transportation Board member(s) feel about the project?

Scale	
10–8	High priority for all parties
8–5	High priority for some parties
5–3	Medium priority for all parties
3–1	Medium priority for some parties
1–0	Low priority

---

*The office cited after each factor is proposed to evaluate and rate the factor under consideration.

<u>Factor C</u>. Need as identified by Department officials. -- Office of Programming.

Criteria:

(i) How urgent does Department officials feel about the project based on inputs from factors B, D, and other political inputs?

(ii) How urgent does Department officials feel about the project based on inputs from factor A and other technical information?

Scale	
10 – 8	High priority, both technical and political
8 – 5	High priority, either technical or political
5 – 3	Medium priority, both technical and political
3 – 1	Medium priority, either technical or political
1 – 0	Low priority

<u>Scale</u>

<u>Factor D</u>. Community response or local opinion. -- Office of Planning

Criteria:

(i) How do citizens in the community feel about the project?

(ii) What is the probability of community acceptance to project?

This factor will probably not be applicable at present due to absence of such community input mechanism, but maybe available in the near future.

Scale	
10 – 8	Strongly in favor
8 – 2	In favor
2 – -4	Indifferent or slight opposition that can be resolved easily
-4 – -8	Some opposition, extent medium or uncertain
-8 – -10	Strong opposition, difficult to resolve differences.

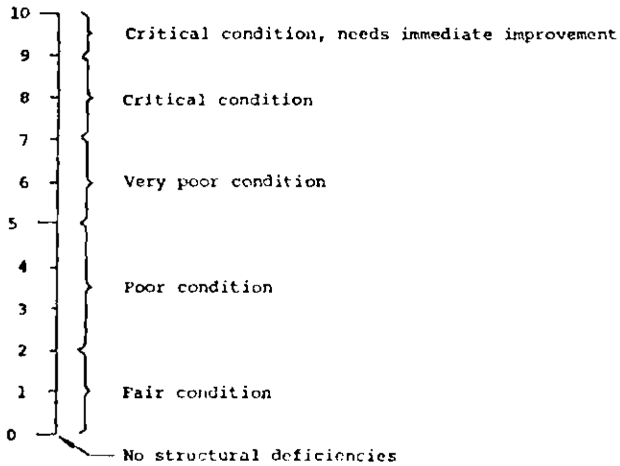
<u>Scale</u>

II. PHYSICAL DEFICIENCY PARAMETER

Factor A. Structure condition--Office of Maintenance

Criteria:
Existing condition of structure in terms of:
(i) Safe load carrying capacity;
(ii) Structural deficiencies;
(iii) Structure width (roadway width).

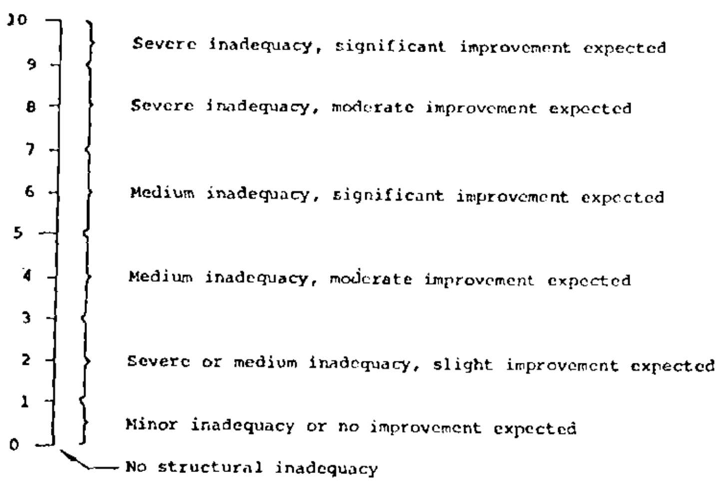
One possible data source is National Bridge Inventory and Appraisal data.
Department presently has such or a similar rating scheme for bridge structures.



Scale

Factor B. Structure adequacy--Office of Maintenance

Criteria:
(i) Remaining life of structure;
(ii) Adequacy of load carrying capacity for future traffic;
(iii) Expected improvement due to project under consideration on structure condition and adequacy.



Scale

Factor C. **Pavement Condition--Office of Maintenance**

Criteria:

(i) Structural condition;
(ii) Surface condition (roughness, cracks, rutting, potholes);
(iii) Skid resistance.

A rating scheme for flexible pavements has been prepared by the Office of Materials and Tests and can be used as criteria when available.

10	
9	Critical condition
8	
7	
	Very poor condition
6	
5	
4	
	Poor condition
3	
2	
1	Fair condition
0	

Factor D. Pavement Adequacy--Office of Maintenance

Criteria:

(i) Remaining life of pavement
(ii) Adequacy of pavement for future traffic;
(iii) Expected improvement due to project under consideration on pavement condition and adequacy.

10	
	Severe inadequacy, significant improvement expected
9	
8	Severe inadequacy, moderate improvement expected
7	
6	Medium inadequacy, significant improvement expected
5	
4	Medium inadequacy, moderate improvement expected
3	
2	Severe or medium inadequacy, slight improvement expected
1	
	Minor inadequacy or no improvement expected
0	

Scale

III. OPERATIONAL DEFICIENCY PARAMETER

__Factor A.__ Existing and projected traffic volume--Office of Planning

Criteria:

(i) Projected rate of growth in traffic volume.

Scale	
10	
	Extremely high rate of growth
9	
8	High rate of growth
7	
6	
	Moderate rate of growth
5	
4	
3	
	Low rate of growth
2	
1	
	No or negative growth
0	

__Scale__

__Factor B.__ Service level - volume/capacity ratio--Office of Planning

Criteria:

(i) Existing v/c ratio;

(ii) Number of years before reaching an unacceptable v/c ratio;

(iii) Expected improvement due to project under consideration on (i) and (ii).

Scale	
10	
	Severe deficiency, significant improvement expected
9	
8	Severe deficiency, moderate improvement expected
7	
6	Medium deficiency, significant improvement expected
5	
4	Medium deficiency, moderate improvement expected
3	
2	Severe or medium deficiency, little improvement expected
1	
	Minor deficiency or no improvement expected
0	

__Scale__

Factor C. Operating speed or delay factor--Office of Traffic Engineering and Safety

Criteria:

(i) Travel time (Speed and delay) as compared to a desirable service level;

(ii) Expected improvement on travel time due to project under consideration.

This factor and the service level factor are closely related and this factor may be eliminated if deemed redundant.

Scale	
10–9	Severe deficiency, significant improvement expected
9–7	Severe deficiency, moderate improvement expected
7–5	Medium deficiency, significant improvement expected
5–3	Medium deficiency, moderate improvement expected
3–1	Severe or medium deficiency, little improvement expected
1–0	Minor deficiency, or no improvement expected

Scale

Factor D. Roadway alignment and geometrics--Office of Planning

Criteria:

(i) Existing conditions as compared to desirable design standards are:
  Roadway width
  Horizontal alignment
  Vertical alignment
  Vertical and horizontal clearance of bridge structures
  Stopping sight distance
  Passing sight distance;

(ii) Expected improvements on existing conditions in (i) due to project under consideration.

Scale	
10–9	Severe deficiency, significant improvement expected
9–7	Severe deficiency, moderate improvement expected
7–5	Medium deficiency, significant improvement expected
5–3	Medium deficiency, moderate improvement expected
3–1	Severe or medium deficiency, little improvement expected
1–0	Minor deficiency or no improvement expected

Scale

IV. SAFETY DEFICIENCY PARAMETER

Factor A. Accident Experience--Office of Traffic Engineering and Safety

Criteria:
(i) Accident rate;
(ii) Fatal accident rate;
(iii) Accident severity rate.

GDOT presently has a program which evaluates the accident experience using these criteria.

Scale	
10	
	Extremely hazardous
9	
8	Hazardous
7	
6	
	Moderate
5	
4	
3	
	Low
2	
1	
	Extremely low
0	

Scale

Factor B. Accident Potential--Office of Traffic Engineering and Safety

Criteria:
(i) Accident potential in terms of the three criteria in factor A. accident rate, fatal accident rate and accident severity rate;
(ii) Expected reduction in accident potential due to project under consideration.

Scale	
10	
	High potential, significant improvement expected
9	
8	High potential, moderate improvement expected
7	
6	Medium potential, significant improvement expected
5	
4	Medium potential, moderate improvement expected
3	
2	High or medium potential, little improvement expected
1	
	Low potential or no improvement expected
0	

Scale

Factor C. Roadway alignment and geometrics--Office of Traffic Engineering and Safety

Criteria:

(i) Existing conditions as compared to desirable design standards in light of safety hazards on:
- Roadway width
- Horizontal alignment
- Vertical alignment
- Vertical and horizontal clearance of bridge structures
- Stopping sight distance
- Passing sight distance;

(ii) Expected improvements on roadway alignment and geometrics in (i) due to project under consideration.

10

9 — Severe deficiency, significant improvement expected

8 — Severe deficiency, moderate improvement expected

7

6 — Medium deficiency, significant improvement expected

5

4 — Medium deficiency, moderate improvement expected

3

2 — Severe or medium deficiency, little improvement expected

1

0 — Minor deficiency or no improvement expected

Scale

V. CONTINUITY PARAMETER

Factor A. Continuity with existing highway network. -- Office of Planning

Criteria:

(i) How much does the project under consideration enhance or improve the continuity of overall highway network?

(ii) Is the project under consideration part of useable segments completion or partially completed improvements?

Scale

Scale	
10	
9	Completion of useable segments and partially completed improvements
8	
7	
	Significant improvement for overall highway network
6	
5	
4	
	Medium improvement for overall highway network
3	
2	
1	Slight improvement for overall highway network
0	

Factor B. Coordination with multi-modal facilities. -- Office of Public Transportation and Research

Criteria:

(i) How well does the project under consideration fit into the multi-modal transportation plan?

(ii) How well does the project under consideration enhance or cooperate with existing multi-modal transportation facilities?

Scale

Scale	
10	
	Extremely positive
8	
6	Positive
4	
2	Slightly positive
0	
	No significance
-2	
-4	Slightly negative
-6	
	Negative
-8	
	Extremely negative
-10	

<u>Factor C.</u> Coordination with other highway improvement projects. -- Office of Programming

Criteria:
How well does the project under consideration coordinate with other projects in terms of:
(i) financial constraints,
(ii) manpower availability, and
(iii) political constraints?

<u>Scale</u>

Scale	
10 to 8	Very desirable
8 to 2	Desirable
2 to -4	Slightly desirable, no significance, or slightly disruptive
-4 to -8	Disruptive
-8 to -10	Very disruptive

(Scale points: 10, 8, 6, 4, 2, 0, -2, -4, -6, -8, -10)

VI. BENEFIT-COST PARAMETER

<u>Factor</u>. Benefit/cost ratio - user benefits only. -- Office of Planning

Criteria:
Benefit/cost ratio based on user benefits only, including:

Highway-user related benefits:	travel cost travel time accident potential travel comfort and convenience
Highway-user related costs:	construction operations and maintenance.

<u>Scale</u>

10
9 Very high benefit/cost ratio
8
7
6 Medium benefit/cost ratio
5
4
3
2 Benefit/cost ratio slightly over 1
1
0 Benefit/cost ratio equal or less than 1

VII. ECONOMIC PARAMETER

<u>Factor A.</u> Comprehensive Plan--Office of Planning

Criteria:

(i) Importance or effect of project under consideration as related to comprehensive plan(s) of the affected community(ies);

(ii) Importance or effect of project as related to other plan(s) of the affected community(ies)?

<u>Factor B.</u> Land value and development-- Office of Planning

Criteria:

(i) Effects of project on existing land value and development in the short run;

(ii) Impacts on future trends of development in the affected community(ies) in the long run?

<u>Factor C.</u> Tax Base-- Office of Planning

Criteria:

(i) Short-run impacts of project under consideration to tax base of affected community(ies), in terms of:
  Commercial (wholesale and retail) activities,
  Business (service) activities,
  Industrial (manufacturing) activities, and
  Recreational (tourism) activities;

(ii) Long-run impacts of project on the tax base.

<u>Factor D.</u> Employment-- Office of Planning

Criteria:

(i) Short-term impacts on employment, such as construction work;

(ii) Long-term impacts on employment (closely related to tax base).

<u>Factor E.</u> Public Services -- Office of Planning

Criteria:

(i) Impacts of project on existing level of public services;

(ii) Impacts of project on future level of public services.

All five factors will be rated on the same scale as shown below:

Scale	
10 to 8	Extremely positive
8 to 4	Very positive
4 to 0	Positive
0	← No effect
0 to -4	Negative
-4 to -8	Very negative
-8 to -10	Extremely negative

<u>Scale</u>

VIII. SOCIAL PARAMETER

Factor A. Displacement and relocations -- Office of Planning

Criteria:
(i) Extent of displacement and relocation of residential units due to project;
(ii) Extent of displacement and relocation of commercial units due to project.

Scale	
0	No displacement or relocation
-1	Small number of displacement, no significant hardship
-2	
-3	Medium number of displacement, no significant hardship
-4	
-5	Small number of displacement, significant hardship
-6	
-7	Medium number of displacement, significant hardship
-8	
-9	Large number of displacement
-10	

Scale

Factor B. Impacts on Social Patterns -- Office of Planning

Criteria:
(i) Changes in neighborhood characteristics due to project
(ii) Impacts of project on minority groups in affected community(ies).

Scale	
10	Extremely positive effect, strong support from neighborhood(s)
8	
6	Very positive effect, some support from neighborhood(s)
4	
2	Positive effect, little support from neighborhood(s)
0	No effect
-2	Minor disruption, slight opposition from neighborhood(s)
-4	
-6	Medium disruption, some opposition from neighborhood(s)
-8	
-10	Severe disruption, strong opposition from neighborhood(s)

Scale

Factor C. Disruption during construction--Office of Planning

Criteria:

(i) Short-term effects on affected community(ies) before and during construction of project, such as traffic congestion, noise and dust and accident potential.

Scale	
0	No disruption
-1	Minor disruption
-2	
-3	
	Medium disruption, slight opposition from neighborhood(s)
-4	
-5	
-6	Severe disruption, slight opposition from neighborhood(s)
-7	
-8	Medium disruption, strong opposition from neighborhood(s)
-9	
	Severe disruption, strong opposition from neighborhood(s)
-10	

Factor D. Preservation of historic, religious and institutional sites--Office of Planning

Criteria:

(i) Will project under consideration require removal of any historic, religious or institutional site(s)?

(ii) If yes, what is the effect of removal of such site(s)?

(iii) If no, what is the effect of the project on such site(s)?

Scale	
10	
8	No removal, positive effect on such site(s)
6	
	No removal, no effect
4	
2	Removal, little or no opposition
0	
-2	No removal, negative effect
-4	
-6	Removal, some opposition
-8	
	Removal, strong opposition
-10	

IX. ENVIRONMENTAL PARAMETER

Factor A. Aesthetics--Office of Planning

Criteria:
(i) Visual effects of project to both highway-users and non-users;
(ii) Change in aesthetics due to project as compared to a no-build situation.

Factor B. Air pollution--Office of Planning

Criteria:
(i) Existing air pollution condition;
(ii) Change in air pollution due to project.

Factor C. Water pollution--Office of Planning

Criteria:
(i) Existing water pollution conditions;
(ii) Expected change in water pollution due to project.

Factor D. Noise pollution--Office of Planning

Criteria:
(i) Existing noise pollution conditions;
(ii) Expected change in noise level due to project.

Factor E. Physical resources--Office of Planning

Criteria:
(i) Extent of usage or disruption to physical resources as compared to the no-build option.

Factor F. Biological resources--Office of Planning

Criteria:
(i) Extent of usage or disruption to biological resources as compared to the no-build option.

All five factors will have the same rating scale shown as follows:

Scale	
10 to 8	Extremely positive
8 to 4	Positive
4 to 0	Slightly positive
0	No effect
0 to -4	Slightly negative
-4 to -8	Negative
-8 to -10	Extremely negative

Scale

APPENDIX C

Typical Project with Data

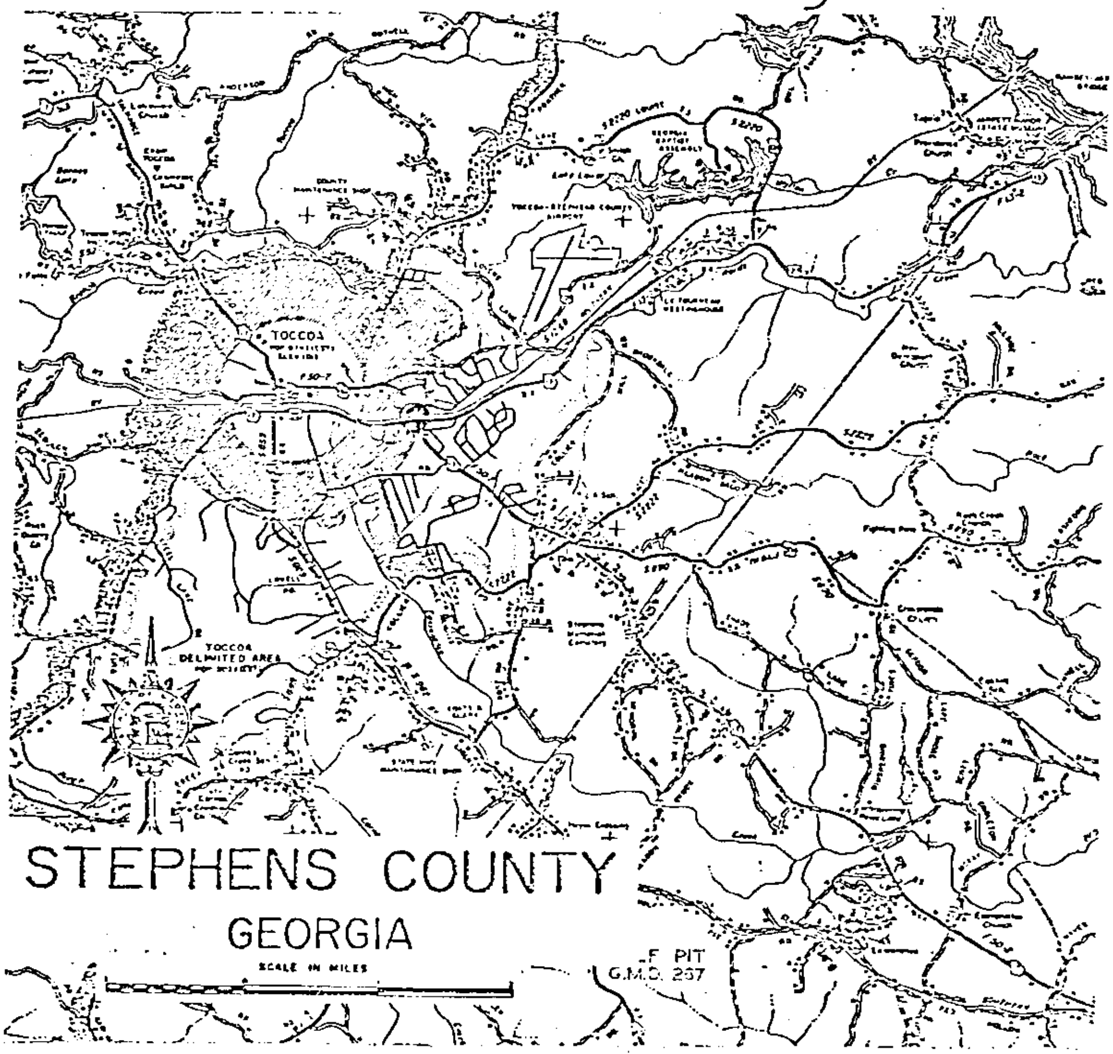
PROJECT: B

Name: Big "A" Rd. in Toccoa (SR-17C) Test Group: 3
Southern Railroad Bridge on SR-17C

Length: 0.3 mile Total Construction Cost: $590,568

P.I. Number: 160011 Project Number: GSB-9-17C (1) Stephens

Type of Work: Widening only
Functional Class: Rural arterial (MINOR ARTERIAL)



Test Group No. 3 Sample Project No. 13

NEED PARAMETER

B. Need as Identified by State, Regional, or Local Officials.

Evaluation Criteria:

1. What priority is assigned to project by local (county or city) officials?

   ___Critical ___High ___Medium ___Low ✓ No Indication

2. How urgent does the officials feel about the project on state or regional levels?

   ___Critical ___High ___Medium ___Low ✓ No Indication

3. How urgent does the State Transportation Board member(s) feel about the project?

   ___Critical ___High ___Medium ___Low ✓ No Indication

Please indicate your rating by placing a (X) mark on the rating scale.

Scale	Rating	
10, 9, 8	High priority for all parties	Score ______
7, 6	High priority for some parties	Not Applicable ✓
5, 4, 3	Medium priority for all parties	
2	Medium priority for some parties	
1, 0	Low priority	

Scale

Test Group No. 3 Sample Project No. B

NEED PARAMETER

B. Need as Identified by State, Regional, or Local Officials.

Evaluation Criteria:

1. What priority is assigned to project by local (county or city) officials?

   ___Critical ___High ___Medium ___Low ✓ No Indication

2. How urgent does the officials feel about the project on state or regional levels?

   ___Critical ___High ___Medium ___Low ✓ No Indication

3. How urgent does the State Transportation Board member(s) feel about the project?

   ___Critical ___High ___Medium ___Low ✓ No Indication

Please indicate your rating by placing a (X) mark on the rating scale.

Scale	Rating
10–8	High priority for all parties
7–5	High priority for some parties
5–3	Medium priority for all parties
3–1	Medium priority for some parties
1–0	Low priority

Scale

Score ________

Not Applicable ✓

Test Group No. 3 Sample Project No. B

NEED PARAMETER

C. Need as Identified by Department Officials.

Evaluation Criteria:

1. How urgent does Department officials feel about the project based on inputs from state, regional or local officials, community response and other political inputs?

   ___Critical ___High ___Medium ___Low ✓ No Indication

2. How urgent does Department officials feel about the project based on inputs from transportation plan(s) and other technical information?

   ___Critical ___High ✓ Medium ___Low ___No Indication

Please indicate your rating by placing a (X) mark on the rating scale.

Score 5

Not Applicable_____

Scale	
10	
9	High priority, both technical and political
8	
7	
6	High priority, either technical or political
5 ✗	
4	Medium priority, both technical and political
3	
2	Medium priority, either technical or political
1	
0	Low priority

Scale

Test Group No. 3 Sample Project No. B

NEED PARAMETER

D. Community Response or Local Opinion

Evaluation Criteria:

1. How do citizens in the community feel about the project?

✓ Strongly in favor ___In Favor ___Indifferent

___Opposition ___ Strong opposition ___No Information

2. What is the probability of community acceptance to project?

✓ No Problem ___Good ___Fair ___Poor ___No Information

Please indicate your rating by placing a (X) mark on the rating scale.

Scale	
10 – 8 (X)	Strongly in favor
6 – 4	In favor
2 – 0 – -2 – -4	Indifferent or slight opposition that can be resolved easily
-6	Some opposition, extent medium or uncertain
-8 – -10	Strong opposition, difficult to resolve differences.

Score 9.5

Not Applicable_______

Test Group No. 3 Sample Project No. 8

PHYSICAL DEFICIENCY PARAMETER

A. Structure Condition

Evaluation Criteria:

1. Existing condition of structure in terms of:
   (i) Safe load carrying capacity;
   (ii) Structural deficiencies; and
   (iii) Structure width (roadway width).

   ___Critical ___Poor ___Fair ___No Deficiencies ___Not Applicable

2. Expected improvement on structure condition due to project under consideration.

   ___Significant ___Moderate ___Slight ___None ___Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale	
10 – 9	Critical condition, significant improvement expected
8 – 7	Critical condition, moderate improvement expected
6 – 5	Poor condition, significant improvement expected
4 – 3	Poor condition, moderate improvement expected
2 – 1	Critical or poor condition, slight improvement expected
1 – 0	Fair condition or no improvement expected
0	No Structural Deficiencies

Score ______

Not Applicable ✓

Test Group No. 3   Sample Project No. 8

PHYSICAL DEFICIENCY PARAMETER

B. Pavement Adequacy

Evaluation Criteria:

1. Remaining life of pavement; 3 Years

2. Adequacy of pavement for future traffic;

   ___Severe Inadequacy ✓ Medium Inadequacy ___Minor Inadequacy

   ___No Inadequacy ___ Not Applicable

3. Expected improvement on pavement adequacy due to project;

   ___Significant ___Moderate ✓ Slight ___None ___Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale		
10	Severe inadequacy, significant improvement expected	
9		
8	Severe inadequacy, moderate improvement expected	Score 3
7		Not Applicable___
6	Medium inadequacy, significant improvement expected	
5		
4	Medium inadequacy, moderate improvement expected	
3 X		
2	Severe or medium inadequacy, slight improvement expected	
1		
0	Minor inadequacy or no improvement expected	

Test Group No. 3 Sample Project No. B

PHYSICAL DEFICIENCY PARAMETER

C. Pavement Condition

Evaluation Criteria:

1. Pavement condition in terms of:

   (i) Structural condition;
   (ii) Surface condition (roughness, cracks, rutting, potholes);
   (iii) Skid resistance

   ___Critical ✓Poor ___Fair ___No Deficiencies ___Not Applicable

2. Expected improvement on pavement condition due to project under consideration.

   ✓Significant ___Moderate ___Slight ___None ___Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

10
9 Critical condition, sifnificant improvement expected
8 Critical condition, moderate improvement expected
7 X
6 Poor condition, signficant improvement expected
5
4 Poor condition, moderate improvement expected
3
2 Critical or poor condition, slight improvement expected
1 Fair condition, or no improvement expected
0 Good Pavement Condition

Scale

Score 7

Not Applicable___

Test Group No. 3 Sample Project No. B

PHYSICAL DEFICIENCY PARAMETER

D. Structure Adequacy

Evaluation Criteria:

1. Remaining life of structure; ________Years

2. Adequacy of load carrying capacity for future traffic;

   ___Severe Inadequacy ___Medium Inadequacy ___Minor Inadequacy

   ___No Inadequacy ___Not Applicable

3. Expected improvement on structure adequacy due to project;

   ___Significant ___Moderate ___Slight ___None ___Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale	
10 – 9	Severe inadequacy, significant improvement expected
9 – 7	Severe inadequacy, moderate improvement expected
7 – 5	Medium inadequacy, significant improvement expected
5 – 3	Medium inadequacy, moderate improvement expected
3 – 1	Severe or medium inadequacy, slight improvement expected
1 – 0	Minor inadequacy or no improvement expected
0	No structural inadequacy

Score________

Not Applicable ✓

Scale

Test Group No. 3　　　　　　　　　　　　Sample Project No. B

OPERATIONAL DEFICIENCY PARAMETER

A. Existing and projected traffic volume

Evaluation Criteria:

1. Existing Traffic Volume.

   ADT 10410 Base Year 1974

2. Projected Traffic Volume.

   ADT 16680 Base Year 1995

3. Projected Rate of Growth in Traffic Volume

   ___Extremely High X High ___Moderate ___Low ___No Growth

   ___Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale		
10 – 9	Extremely high rate of growth	Score 7.5
8 – 7 (X)	High rate of growth	Not Applicable______
6 – 4	Moderate rate of growth	
3 – 2	Low rate of growth	
1 – 0	No or negative growth	

Scale

Test Group No. 3 ________ Sample Project No. B ____

OPERATIONAL DEFICIENCY PARAMETER

B. Service Level - Volume/Capacity Ratio

Evaluation Criteria:

1. Existing Volume/Capacity Ratio

   V/C Ratio ____________

2. Number of years vefore reaching an unacceptable volume/capacity ratio.

   Year__________ V/C Ratio______

3. Expected improvement on Volume/Capacity ratio due to project.

   ___Significant ___Moderate ___Slight ___ No ___Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale	
10–9	Severe deficiency, significant improvement expected
9–7	Severe deficiency, moderate improvement expected
7–5	Medium deficiency, significant improvement expected
5–3	Medium deficiency, moderate improvement expected
3–1	Severe or medium deficiency, little improvement expected
1–0	Minor deficiency or no improvement expected

Score_____

Not Applicable______

Test Group No. 3 Sample Project No. B

OPERATIONAL DEFICIENCY PARAMETER

C. Operating Speed or Delay Factor

Evaluation Criteria:

1. Travel time (Speed and delay) as compared to a desirable service level;

✓ Severe Deficiency ___Medium Deficiency ___Minor Deficiency

___No Deficiency ___Not Applicable

2. Expected improvement on travel time due to project.

✓ Significant ___Moderate ___ Slight ___No ___ Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale	
10	
9 X	Severe deficiency, significant improvement expected
8	Severe deficiency, moderate improvement expected
7	
6	Medium deficiency, significant improvement expected
5	
4	Medium deficiency, moderate improvement expected
3	
2	Severe or medium deficiency, little improvement expected
1	
0	Minor deficiency, or no improvement expected

Score 9

Not Applicable______

Test Group No. 3 Sample Project No. B

OPERATIONAL DEFICIENCY PARAMETER

D. Roadway Alignment and Geometrics

Evaluation Criteria:

1. Existing conditions as compared to desirable design standards on:

   Roadway width
   Horizontal alignment
   Vertical alignment
   Vertical and horizontal clearance of bridge structures
   Stopping sight distance
   Passing sight distance

   ✓ Severe Deficiency ___Medium Deficiency ___Minor Deficiency

   ___No Deficiency ___Not Applicable

2. Expected improvements on existing conditions due to project.

   ✓ Significant ___Moderate ___Slight ___No ___Not Applicable

   Please indicate your rating by placing a (X) mark on the rating scale.

Scale	
10	
9 (X)	Severe deficiency, significant improvement expected
8	Severe deficiency, moderate improvement expected
7	
6	Medium deficiency, significant improvement expected
5	
4	Medium deficiency, moderate improvement expected
3	
2	Severe or medium deficiency, little improvement expected
1	
0	Minor deficiency or no improvement expected

Score 9.5

Not Applicable ____

Test Group No. 3 Sample Project No. R

SAFETY DEFICIENCY PARAMETER

A. Accident Experience

Evaluation Criteria:

1. Accident experience in terms of:

(i) Accident rate; ________ Acc/MVM

(ii) Fatal accident rate; ________ Acc/MVM

(iii) Accident severity rate ________ Acc/MVM

____Extremely hazardous ____Hazardous ✓ Moderate ____low

____Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

10 — Extremely hazardous
9
8 — Hazardous
7
6
5 X — Moderate
4
3
2 — Low
1
0 — Extremely low

Scale

Score 5

Not Applicable________

Test Group No. 3 Sample Project No. B

SAFETY DEFICIENCY PARAMETER

B. Accident Potential

Evaluation Criteria:

1. Accident potential in terms of:

(i) Accident rate ______ Acc./MVM

(ii) Fatal Accident rate ______ Acc./MVM

(iii) Severity accident rate ______ Acc./MVM

____High ✓ Medium ____Low

2. Expected reduction in accident potential due to project.

____Significant ✓ Moderate ____Slight ____No ______Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Score 6

Not Applicable________

Scale	
10	
9	High potential, significant improvement expected
8	High potential, moderate improvement expected
7	
6 X	Medium potential, significant improvement expected
5	
4	Medium potential, moderate improvement expected
3	
2	High or medium potential, little improvement expected
1	Low potential or no improvement expected
0	

Test Group No. 3 Sample Project No. B

SAFETY DEFICIENCY PARAMETER

C. Roadway Alignment and Geometrics

Evaluation Criteria:

1. Existing conditions as compared to desirable design standards in light of safety hazards on:

   Roadway width
   Horizontal alignment
   Vertical alignment
   Vertical and horizontal clearance of bridge structures
   Stopping sight distance
   Passing sight distance;

   _✓_ Severe Deficiency ___ Medium Deficiency ___ Minor Deficiency

   ___ No Deficiency ___ Not Applicable

2. Expected improvements on roadway alignment and geometrics due to project.

   ___ Significant _✓_ Moderate ___ Slight ___ No ___ Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale		
10		
9	Severe deficiency, significant improvement expected	Score 8
8 X	Severe deficiency, moderate improvement expected	Not Applicable ___
7		
6	Medium deficiency, significant improvement expected	
5		
4	Medium deficiency, moderate improvement expected	
3		
2	Severe or medium deficiency, little improvement expected	
1		
0	Minor deficiency or no improvement expected	

Scale

Test Group No. 7 Sample Project No. 8

CONTINUITY PARAMETER

A. Continuity with Existing Highway Network

Evaluation Criteria:

1. Is the project under consideration part of useable segments completion or partially completed improvements?

✓ Yes ___ No ___ Not Applicable

2. How much does the project under consideration enhance or improve the continuity of overall highway network?

✓ Significant ___ Moderate ___ Slight ___ No ___ Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale

Scale	Description
10	
9 X	Completion of useable segments and partially completed improvements
8	
7	
6	Significant improvement for overall highway network
5	
4	
3	Medium improvement for overall highway network
2	
1	Slight improvement for overall highway network
0	

Score 9.0

Not Applicable ___

Test Group No. 3 Sample Project No. B

CONTINUITY PARAMETER

B. Coordination with Multi-Modal Facilities

Evaluation Criteria:

1. How well does the project under consideration fit into the multi-modal transportation plan?

   ___Extremely Positive Effect ___Positive _✓_No Significance

   ___Negative ___Extremely Negative Effect ___Not Applicable

2. How well does the project under consideration enhance or cooperate with existing multi-modal transportation facilities?

   ___Extremely Positive Effect ___Positive _✓_No Significance

   ___Negative ___Extremely Negative Effect ___Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale

10 }
8 } Extremely positive
6 } Positive
4
2 } Slightly positive
0 X } No significance
-2
-4 } Slightly negative
-6
-8 } Negative
-10 } Extremely negative

Score 0

Not Applicable____

Test Group No. 3 Sample Project No. B

CONTINUITY PARAMETER

C. Coordination with Other Highway Improvement Projects

Evaluation Criteria:

1. How well does the project under consideration coordinate with other projects in terms of:

   (i) financial constraints,
   (ii) manpower availability, and
   (iii) political constraints?

___Very Desirable _✓_Desirable ___No Significance ___Disruptive

___Very Disruptive ___Not applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale

Scale	Rating
10 to 8	Very desirable
8 to 2	Desirable
2 to -4	Slightly desirable, no significance, or slightly disruptive
-4 to -8	Disruptive
-8 to -10	Very disruptive

Scale values: 10, 8, 6, 4, 2, 0, -2, -4, -6, -8, -10

Score 4

Not Applicable___

Test Group No. 7 　　　　　　　　　　 Sample Project No. B

BENEFIT-COST PARAMETER

A. Benefit/cost ratio - user benefits only

Evaluation Criteria:

1. Benefit/cost ratio based on user benefits only.

   B/C Ratio ________

   Please indicate your rating by placing a (X) mark on the rating scale.

Scale

Scale	Description
10	
9	Very high benefit/cost ratio
8	
7	
6	Medium benefit/cost ratio
5	
4	
3	
2	Benefit/cost ratio slightly over 1
1	
0	Benefit/cost ratio equal or less than 1

Score ________

Not Applicable ______ .

Test Group No. 3 Sample Project No. 8

ECONOMIC PARAMETER

A. Conformity with State, Regional or Local Comprehensive and Development Plan(s)

Evaluation Criteria:

1. Importance or effect of project under consideration as related to comprehensive plan(s) of the affected community(ies);

   ___Extremely Positive ____Positive ___No Significance

   __Negative ___Extremely Negative ____Not Applicable

2. Importance or effect of project as related to other plan(s) of the affected community(ies)?

   __Extremely Positive ____Positive ___No Significance ____Negative

   ___Extremely Negative ___Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale	
10	Extremely positive
8	
6	Very positive
4	
2	Positive
0	← No effect
-2	Negative
-4	
-6	Very negative
-8	
-10	Extremely negative

Scale

Score____

Not Applicable___

Test Group No. 3 Sample Project No. B

ECONOMIC PARAMETER

B. Impacts on Land Value and Development

Evaluation Criteria:

1. Effects of project on existing land value and development in the short run;

   ___Extremely Postive ___Positive ___No Significance ___Negative

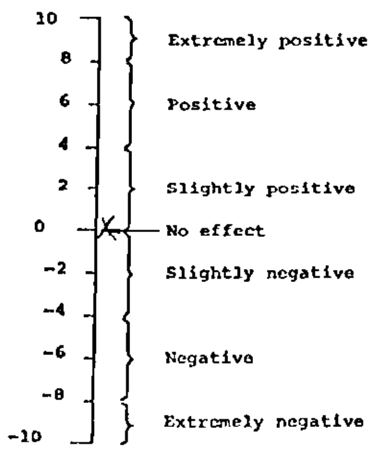
   ___Extremely Negative ✓Not Applicable

2. Impacts on future trends of development in the affected community(ies) in the long run?

   ___Extremely Positive ___Positive ___No Significance ___Negative

   ___Extremely Negative ✓Not Applicable

   Please indicate your rating by placing a (X) mark on the rating scale.



Scale

Score____

Not Applicable____

Test Group No. 3 Sample Project No. 8

ECONOMIC PARAMETER

C. Impacts on Tax Base

Evaluation Criteria:

1. Short-run impacts of project under consideration to tax base of affected community(ies), in terms of:
   Commercial (wholesale and retail) activities,
   Business (service) activities,
   Industrial (manufacturing) activities, and
   Recreational (tourism) activities;

   ____Extremely Positive __Positive __No Significance ____Negative

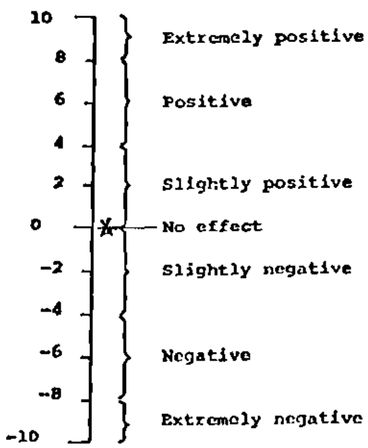
   ____Extremely Negative ✓ Not Applicable

2. Long-run impacts of project on the tax base.

   ____Extremely Positive _____Positive __No Significance ____Negative

   ____Extremely Negative ✓ Not Applicable

   Please indicate your rating by placing a (X) mark on the rating scale.



Scale

Score____

Not Applicable____

Test Group No. 3 Sample Project No. B

SOCIAL PARAMETER

C. Disruption to Communities During Construction

Evaluation Criteria:

1. Short-term effects on affected community(ies) before and during construction of project, such as traffic congestion, noise and dust and accident potential.

   a. ___Severe Disruption ✓ Medium Disruption ___Minor Disruption

      ___No Disruption ___Not Applicable

   b. ___Strong Opposition ___Some Opposition ✓ No Opposition

   Please indicate your rating by placing a (X) mark on the rating scale.

Scale	
0	No disruption
-1	Minor disruption
-2	
-3 X	
-4	Medium disruption, slight opposition from neighborhood(s)
-5	
-6	Severe disruption, slight opposition from neighborhood(s)
-7	
-8	Medium disruption, strong opposition from neighborhood(s)
-9	
-10	Severe disruption, strong opposition from neighborhood(s)

Score 3

Not Applicable____

Test Group No. 3 Sample Project No. B

ENVIRONMENTAL PARAMETER

A. Impacts on Aesthetics and Scenic Enhancement

Evaluation Criteria:

1. Visual effects of project to both highway-users and non-users;

   ____Extremely Positive ____Positive ____No Significance

   ____Negative ____Extremely Negative ✓ Not Applicable

2. Change in aesthetics due to project as compared to a no-build situation.

   ____Extremely Positive ____Positive ___No Significance

   ____Negative ___Extremely Negative ✓ Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale	Rating
10	Extremely positive
8	
6	Positive
4	
2	Slightly positive
0 X	No effect
-2	Slightly negative
-4	
-6	Negative
-8	
-10	Extremely negative

Scale

Score________

Not Applicable_____

Test Group No. 3 Sample Project No. B

ENVIRONMENTAL PARAMETER

C. Impacts on Water Pollution

Evaluation Criteria:

1. Existing water pollution condition and expected changes due to project.

   ___Extremely Positive ___Positive ___No Significance

   ___Negative ___Extremely Negative _✓_Not Applicable

   Please indicate your rating by placing a (X) mark on the rating scale.

Scale	
10	Extremely positive
8	
6	Positive
4	
2	Slightly positive
0 X	No effect
-2	Slightly negative
-4	
-6	Negative
-8	
-10	Extremely negative

Score_____

Not Applicable_____

Test Group No. 3 Sample Project No. R

ENVIRONMENTAL PARAMETER

E. Impacts on Physical Resources

Evaluation Criteria:

1. Extent of usage or disruption to physical resources as compared to the no-build option.

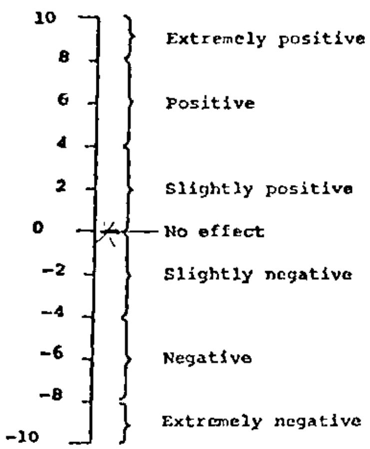
   ____Extremely Positive ___Positive ___No Signficance

   _____Negative ___Extremely Negative ✓ Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Score____

Not Applicable____



Scale

Test Group No. 3 Sample Project No. 8

ENVIRONMENTAL PARAMETER

F. Impacts on Biological Resources

Evaluation Criteria:

1. Extent of usage or disruption to biological resources as compared to the no-build option.

____ Extremely Positive ____ Positive ____ No Significance

____ Negative ____ Extremely Negative ✓ Not Applicable

Please indicate your rating by placing a (X) mark on the rating scale.

Scale	
10	Extremely positive
8	
6	Positive
4	
2	Slightly positive
0 X	No effect
-2	Slightly negative
-4	
-6	Negative
-8	
-10	Extremely negative

Score____

Not Applicable____

Scale

3rd ROUND FEEDBACK SHEET

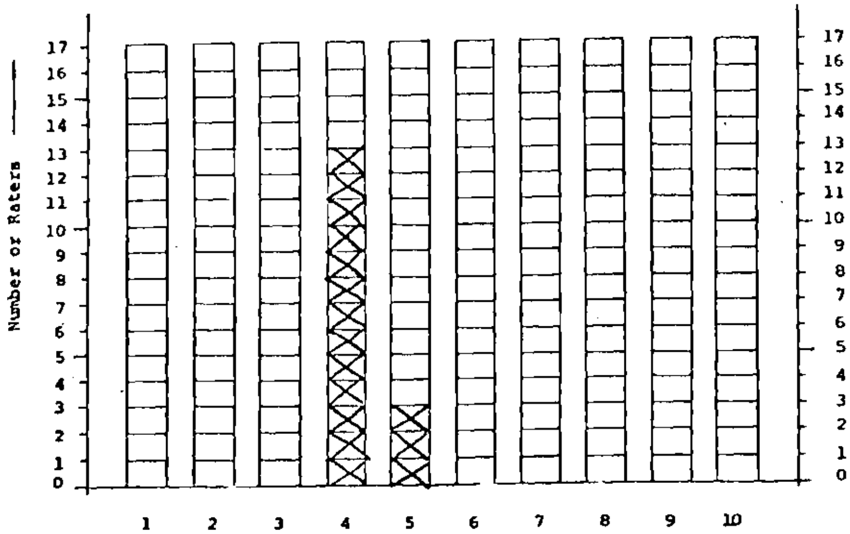
Test Group: 3

Functional Class: Rural arterial

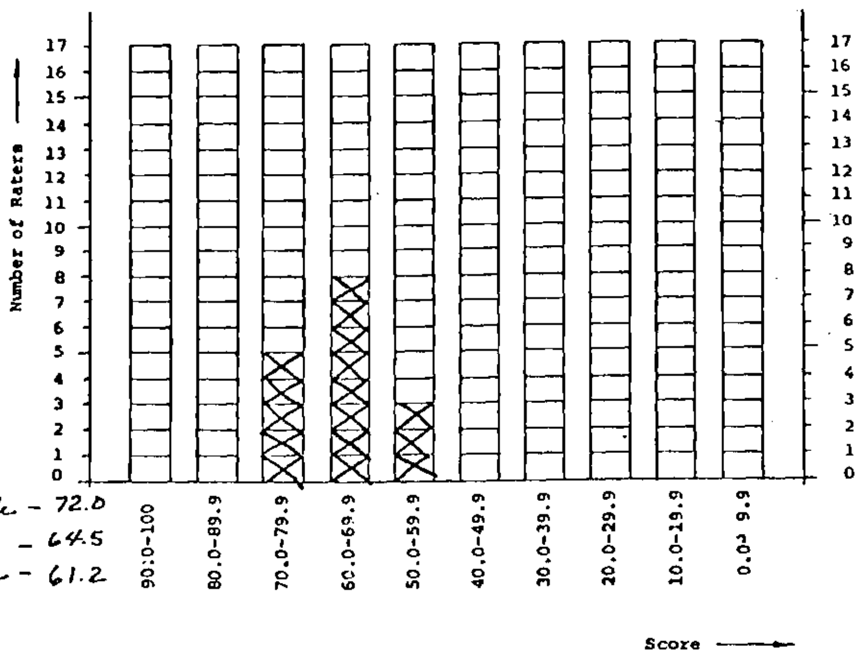
Type of Work: Minor upgrading

			Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9	Rank 10
3rd Round	Project		J	B	G	A	C	I	E	H	D	F
		Mode	1	2	3	4	5	6	7	8	9	10
	Score	1st Quartile	83.0	74.0	71.1	61.2	56.0	52.0	41.1	40.9	32.7	31.8
		Mean	85.4	77.2	71.8	64.5	61.4	54.6	44.8	44.5	37.9	32.2
		3rd Quartile	92.0	84.0	80.0	72.0	67.5	60.0	50.0	48.2	40.0	39.1

Round: 3rd   Test Group: 3   Project: A

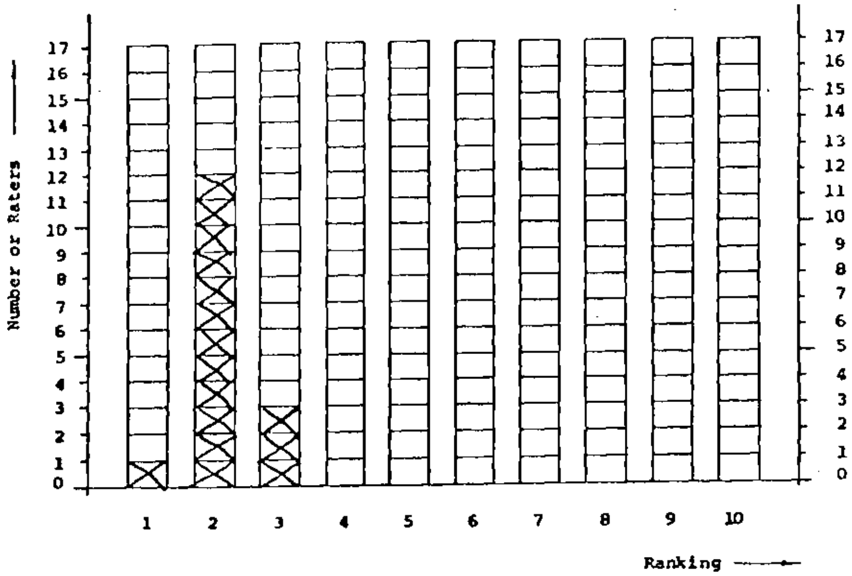


Mode - 4

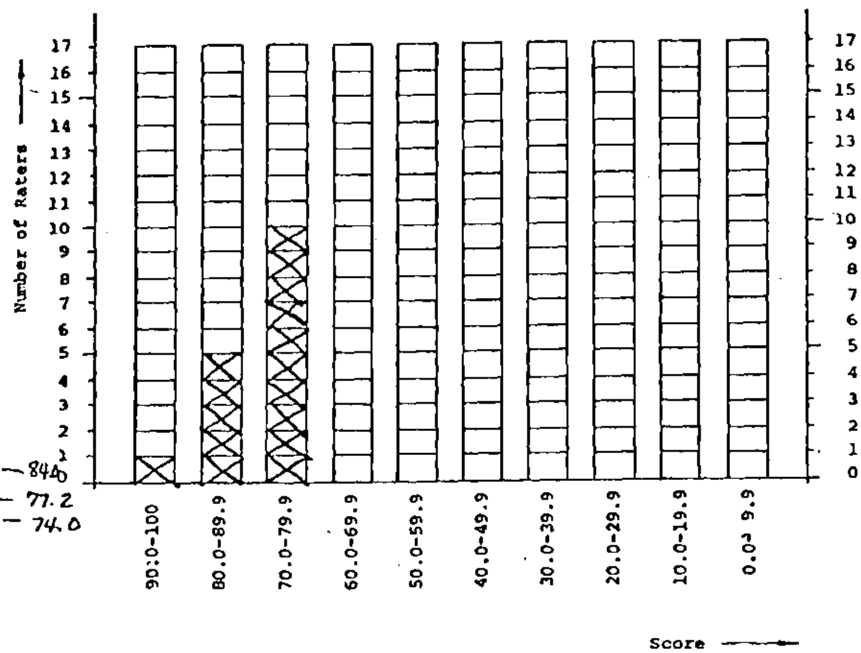


3rd quartile - 72.0
mean - 64.5
1st quartile - 61.2

Round: 3rd Test Group: 3 Project: B

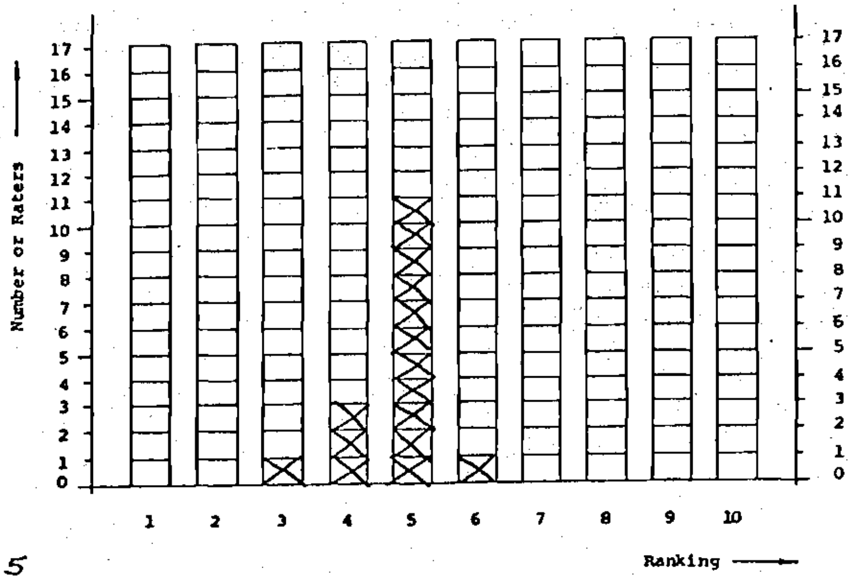


Mode - 2

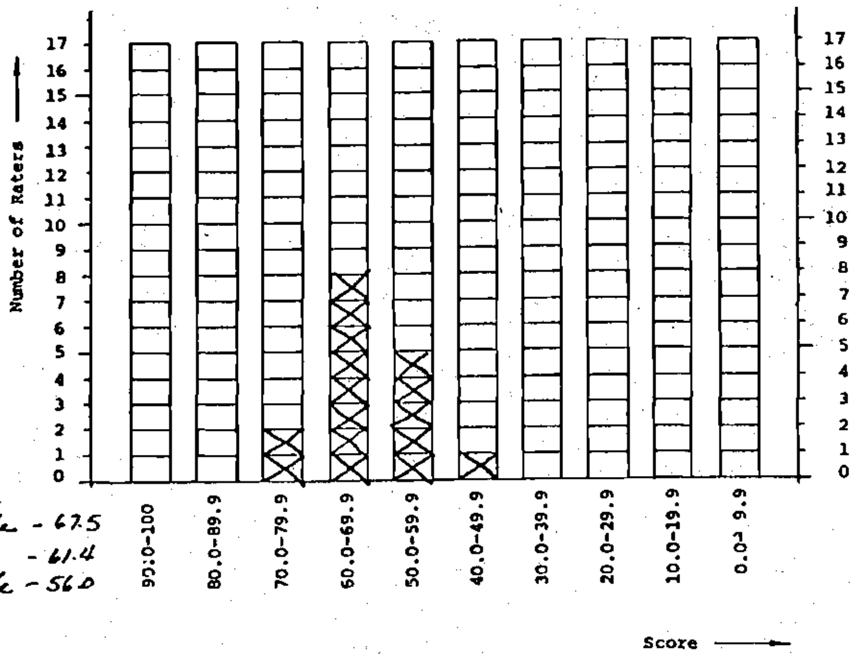


3rd quartile - 84.0
median - 77.2
1st quartile - 74.0

Round: 3rd Test Group: 3 Project: C

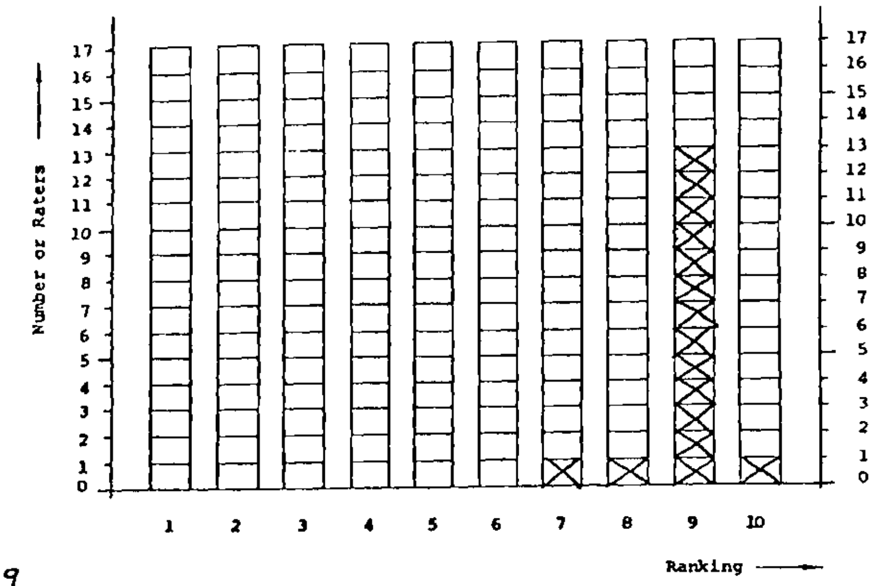


Mode - 5

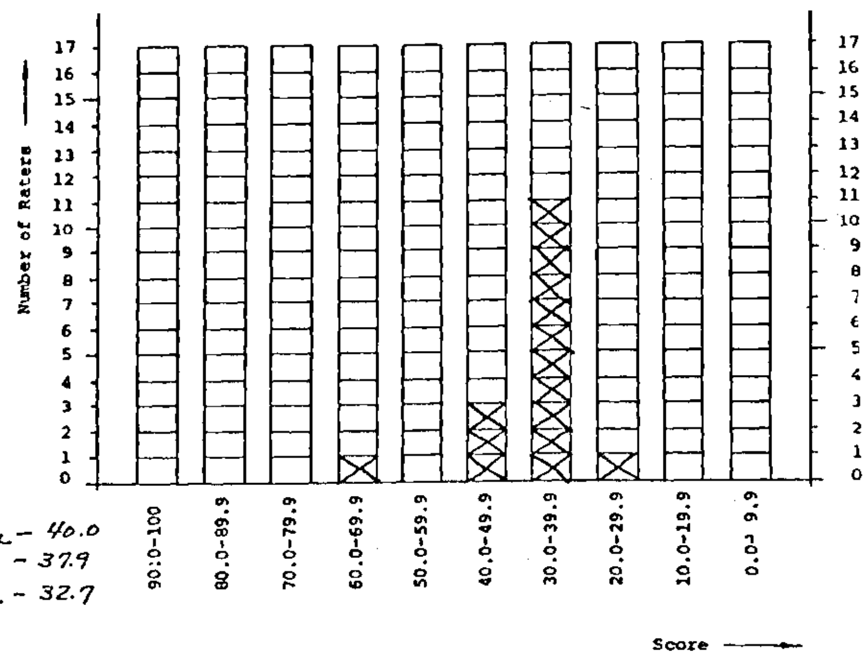


3rd quartile - 67.5
mean - 61.4
1st quartile - 56.0

Round: 3rd Test Group: 3 Project: D

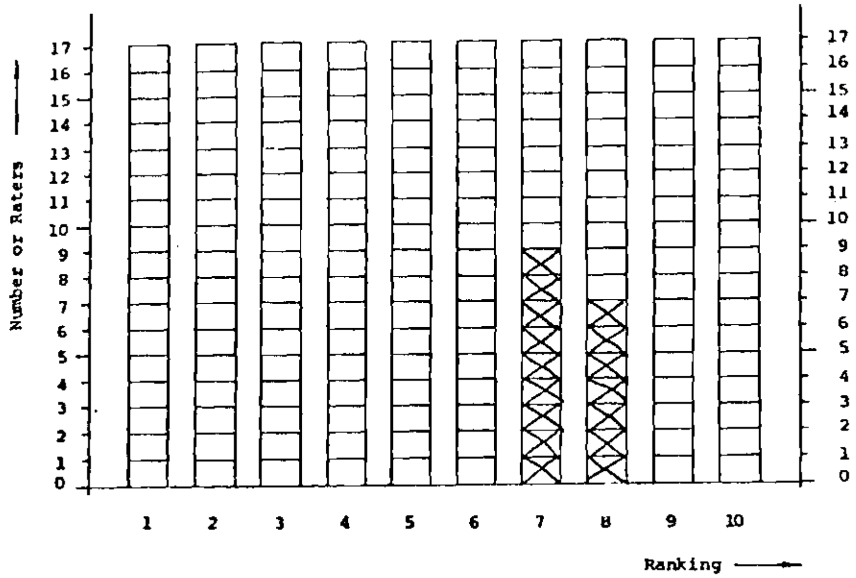


Mode - 9

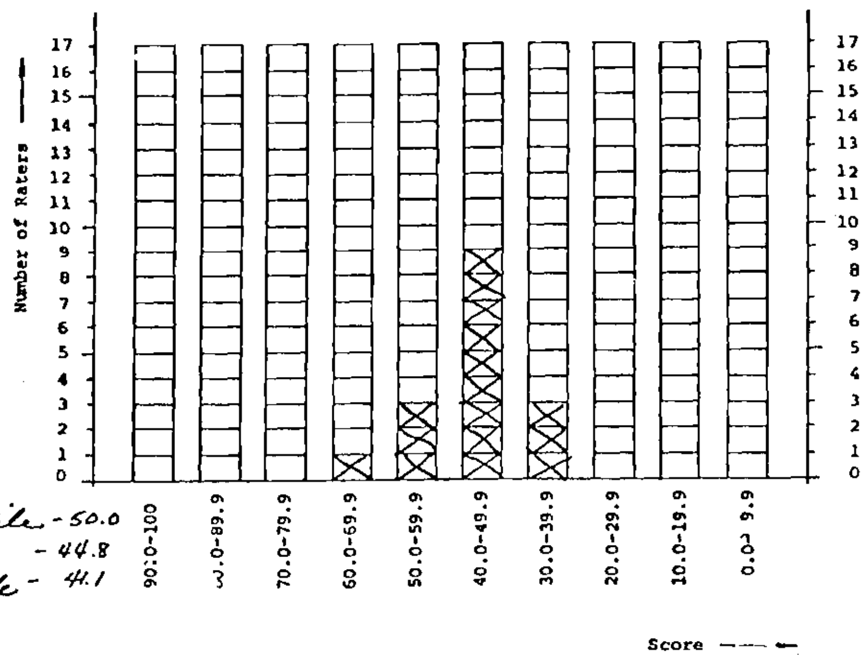


3rd quartile - 40.0
mean - 37.9
1st quartile - 32.7

Round: 3rd Test Group: 3 Project: E

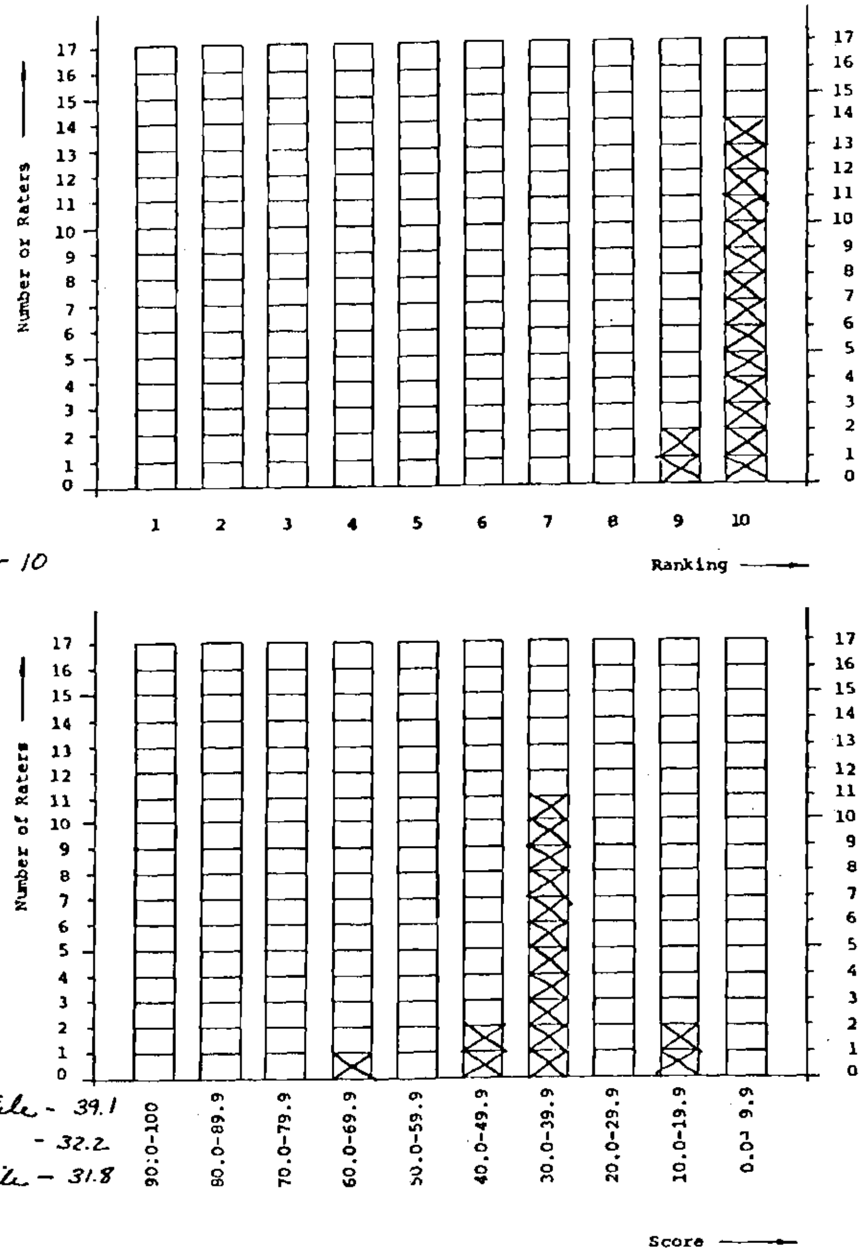


Mode - 7



3rd quartile - 50.0
mean - 44.8
1st quartile - 41.1

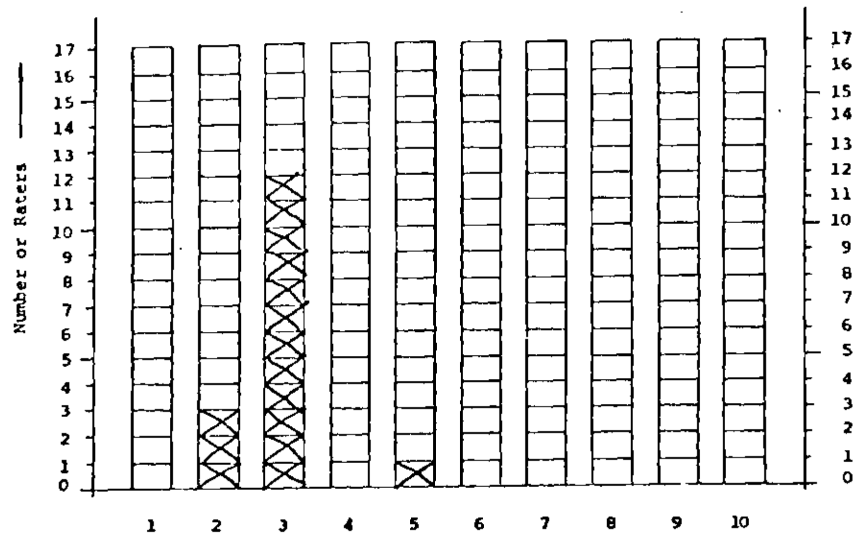
Round: 3rd Test Group: 3 Project: F



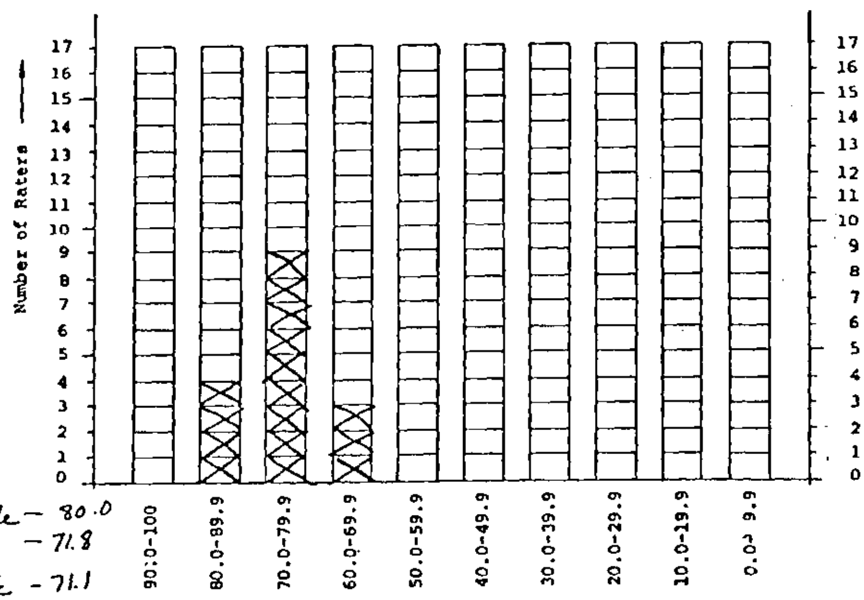
Mode - 10

3rd quartile - 39.1
mean - 32.2
1st quartile - 31.8

Round: 3rd　　Test Group: 3　　Project: 6

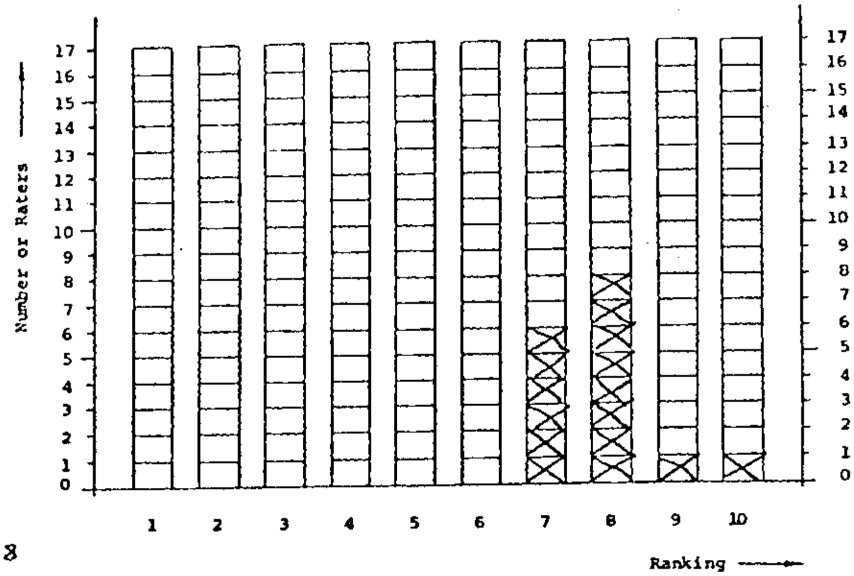


Mode - 3

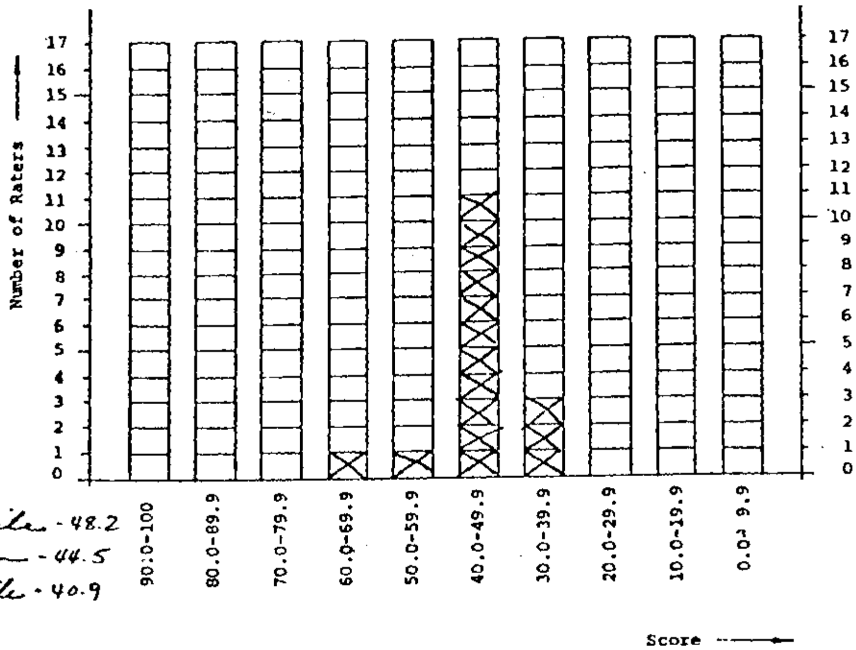


3rd quartile - 80.0
Mean - 71.8
1st quartile - 71.1

Round: 3rd Test Group: 3 Project: H

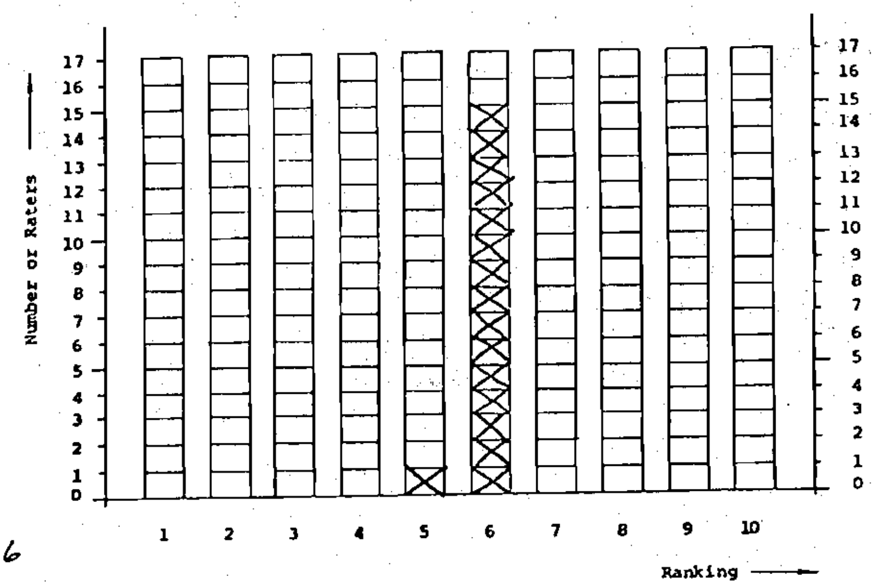


Mode - 8

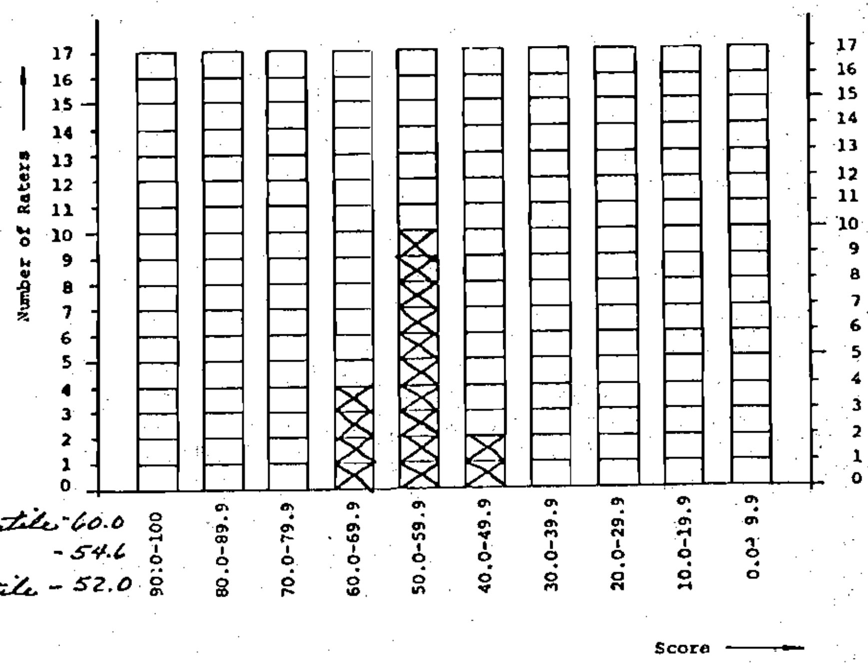


3rd quartile - 48.2
mean - 44.5
1st quartile - 40.9

Round: 3rd　　Test Group: 3　　Project: I

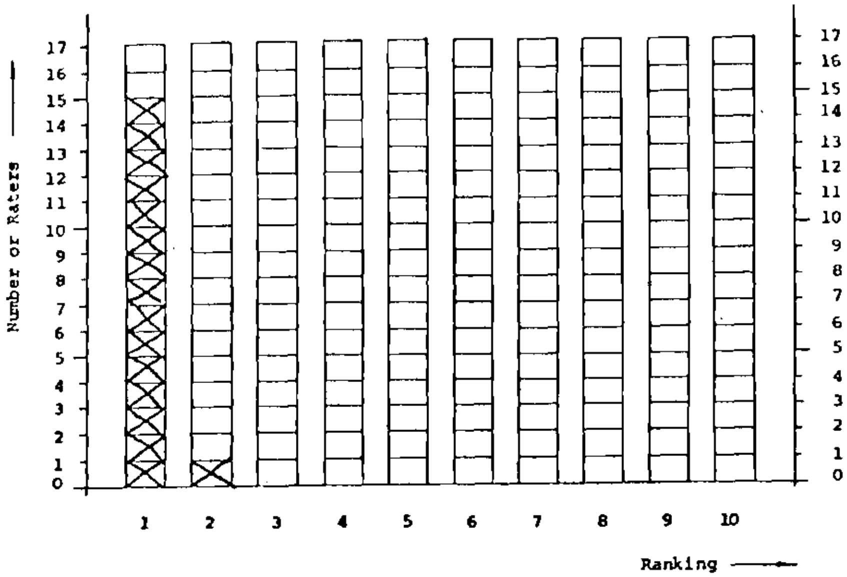


Mode - 6

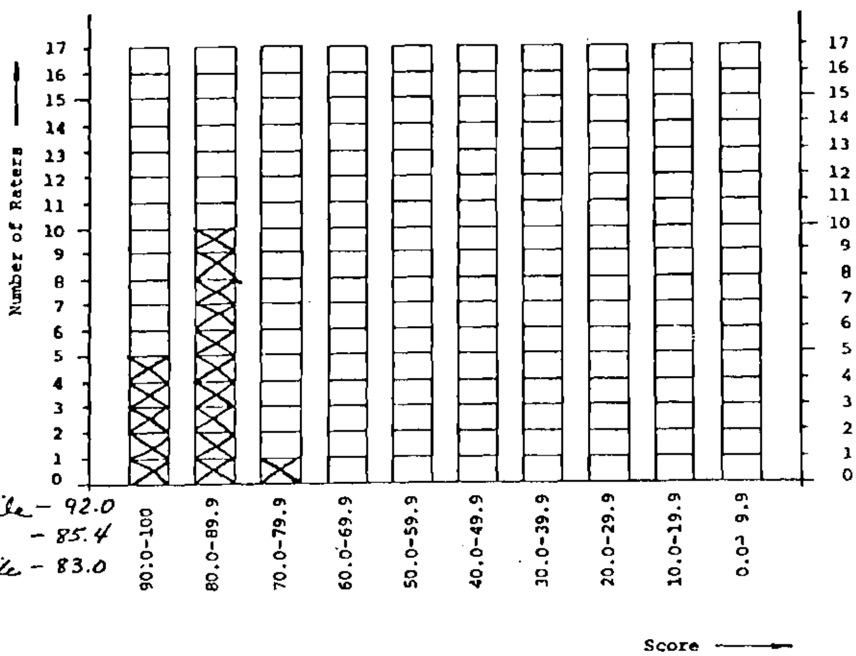


3rd quartile - 60.0
mean - 54.6
1st quartile - 52.0

Round: 3rd Test Group: 3 Project: J



Mode - 1



3rd quartile - 92.0
mean - 85.4
1st quartile - 83.0

EXAMPLE CALCULATION

GROUP 3 - RURAL ARTERIALS - PROJECT B

MINOR UPGRADINGS

I. $\frac{6.1 \times - + 7.0 \times - + 8.6 \times 5 + 5.1 \times 9.5}{8.6 + 5.1} = 6.7$

II. $\frac{8.7 \times - + 8.7 \times 3 + 8.7 \times 7 + 8.7 \times -}{8.7 + 8.7} = 5.0$

III. $\frac{6.7 \times 7.5 + 6.5 \times - + 6.3 \times 9 + 5.7 \times 9.5}{6.7 + 6.3 + 5.7} = 8.7$

IV. $\frac{7.9 \times 5 + 6.8 \times 6 + 5.7 \times 8}{7.9 + 6.8 + 5.7} = 6.1$

V. $\frac{4.7 \times 9 + 5.3 \times 0 + 6.0 \times 4}{4.7 + 5.3 + 6.0} = 4.1$

VI. $\frac{4.4 \times -}{-} = -$

VII. $\frac{4.9 \times - + 4.2 \times 0 + 4.4 \times 0 + - \times - + - \times -}{4.2 + 4.4} = 0$

VIII. $\frac{- \times - + - \times - + 4.9 \times (-1) + - \times -}{4.9} = -1.0$

IX $\frac{4.7 \times 0 + - \times - + 6.5 \times (-1) + - \times - + 5.0 \times 0 + 5.0 \times 0}{4.7 + 6.5 + 5.0 + 5.0} = -0.3$

MODEL SCORE

$$\frac{6.7\times6.7 + 5.0\times8.7 + 8.7\times6.3 + 6.1\times6.8 + 4.1\times5.3 + 0\times2.7 + (-1)\times1.2 + (-0.3)\times3.5}{6.7 + 8.7 + 6.3 + 6.8 + 5.3 + 2.7 + 1.2 + 3.5}$$

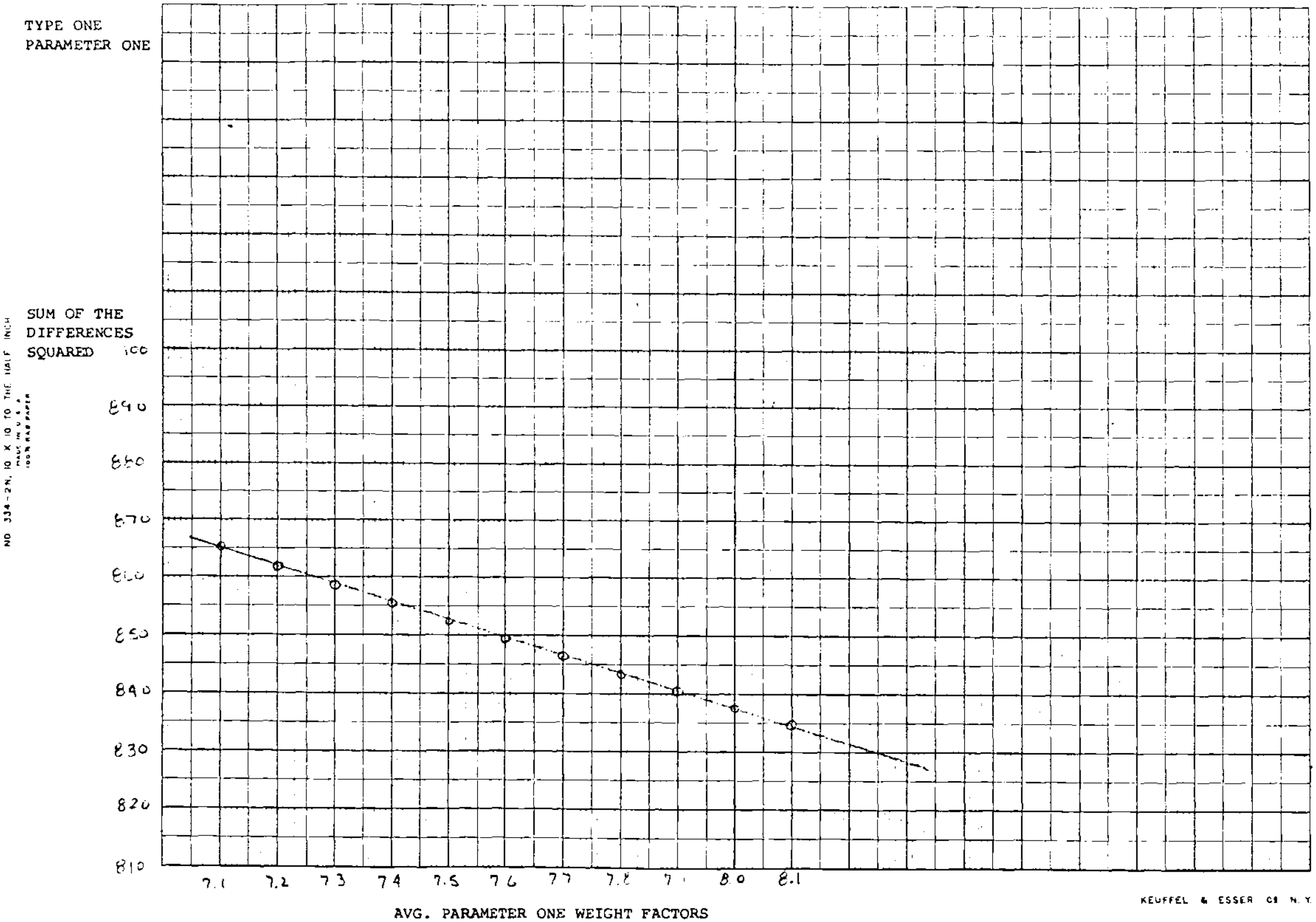
$$= \frac{48.5}{10} \text{ or } 49$$

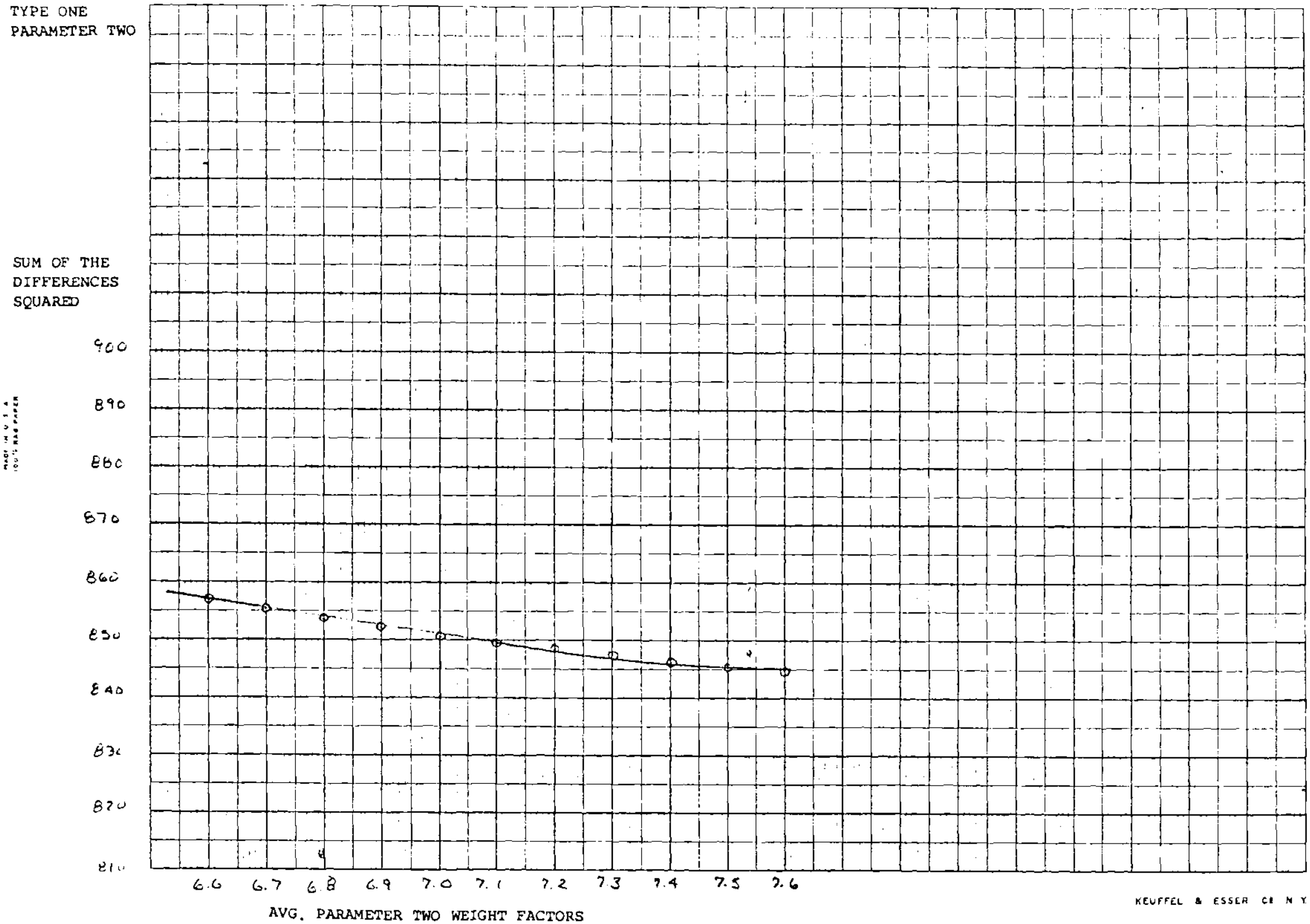
APPENDIX D

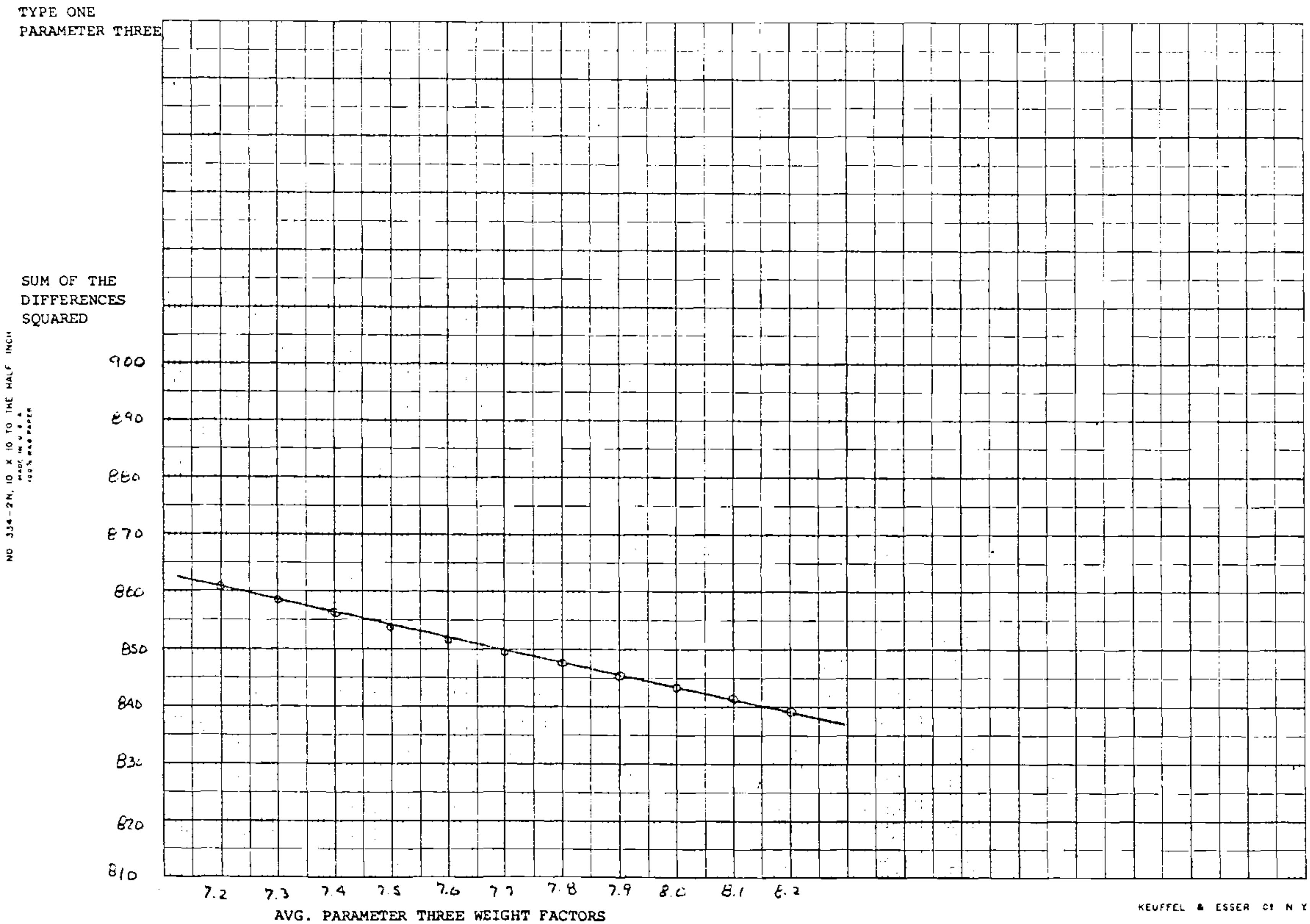
Plot of Adjustment of Weight Factors for Each Type Improvement

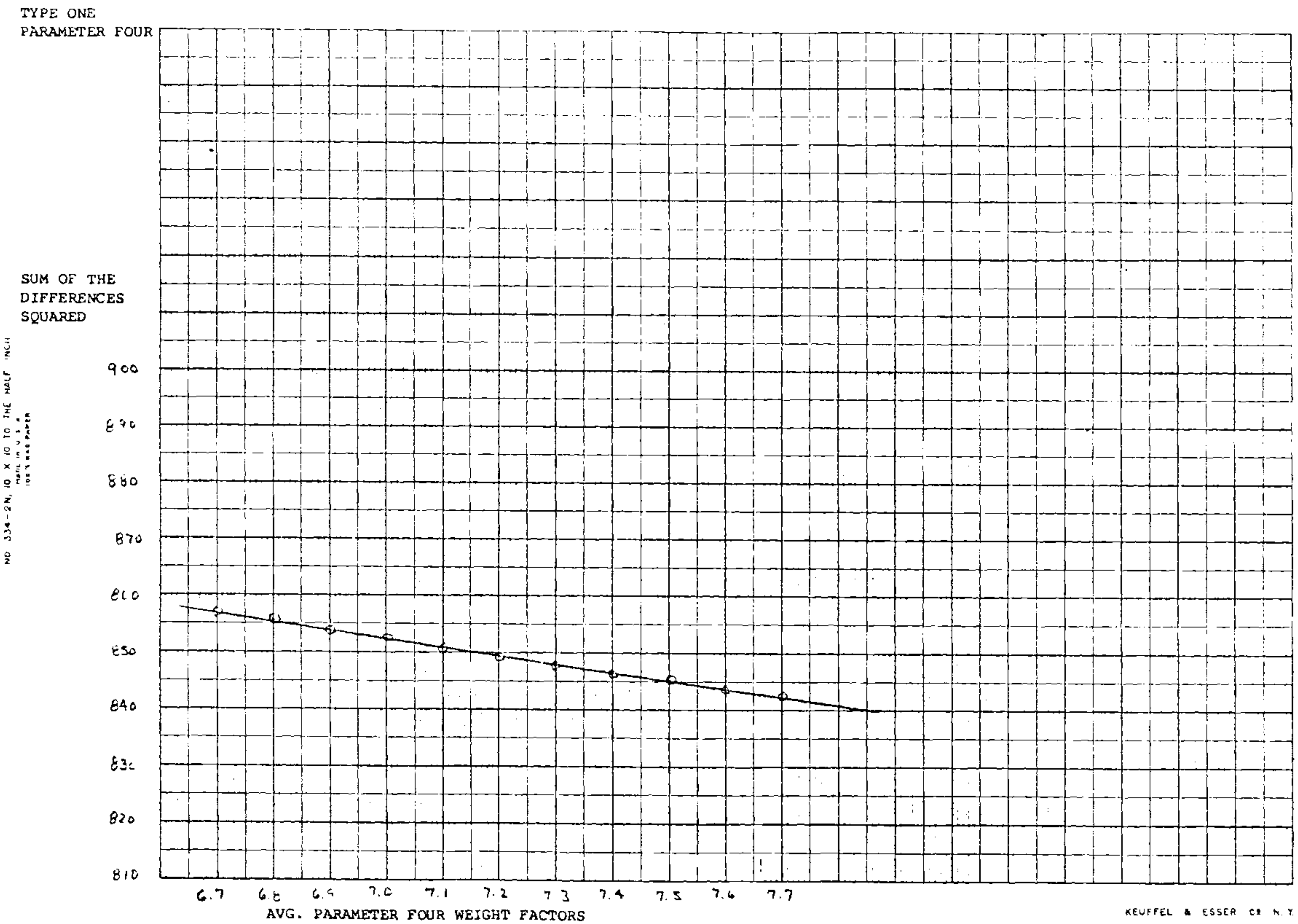
Improvement type 1	New Construction
Improvement type 2	Reconstruction and Major Highway Upgrading
Improvement type 3	Minor Highway Upgrading
Improvement type 4	Structures, New and Replacements
Improvement type 5	Safety Improvements
Improvement type 6	Traffic Engineering Improvements

Parameter 1	Need
Parameter 2	Physical Deficiency
Parameter 3	Operational Deficiency
Parameter 4	Safety Deficiency
Parameter 5	Continuity
Parameter 6	Benefit-Cost
Parameter 7	Economic
Parameter 8	Social
Parameter 9	Environmental

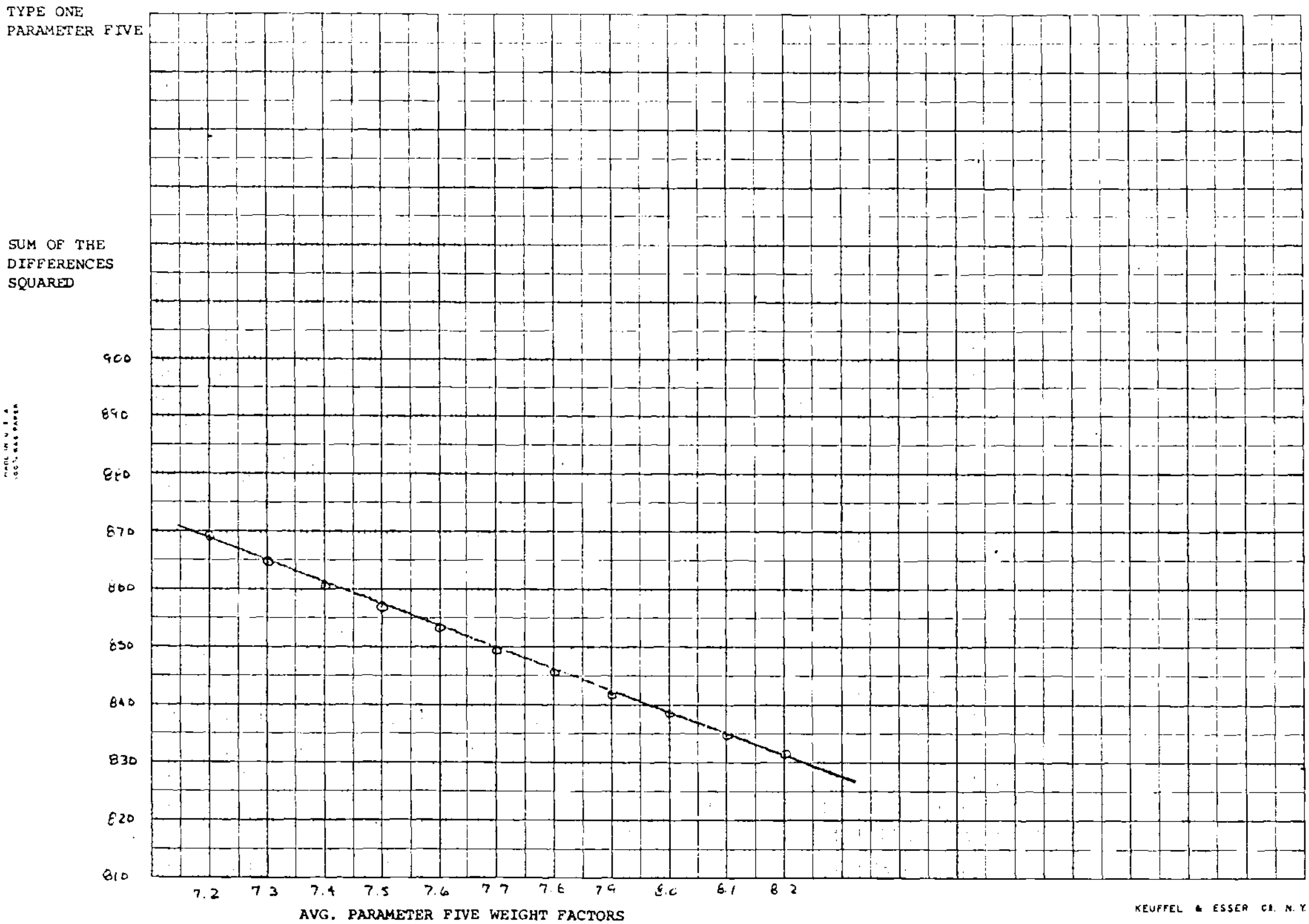

TYPE ONE
PARAMETER ONE
SUM OF THE
DIFFERENCES
SQUARED
890
880
870
850
840
830
820
810
7.1
7.2
7.3
7.4
7.5
7.6
7.7
7.8
8.0
8.1
AVG. PARAMETER ONE WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.
ND 334-2N, 10 X 10 TO THE HALF INCH

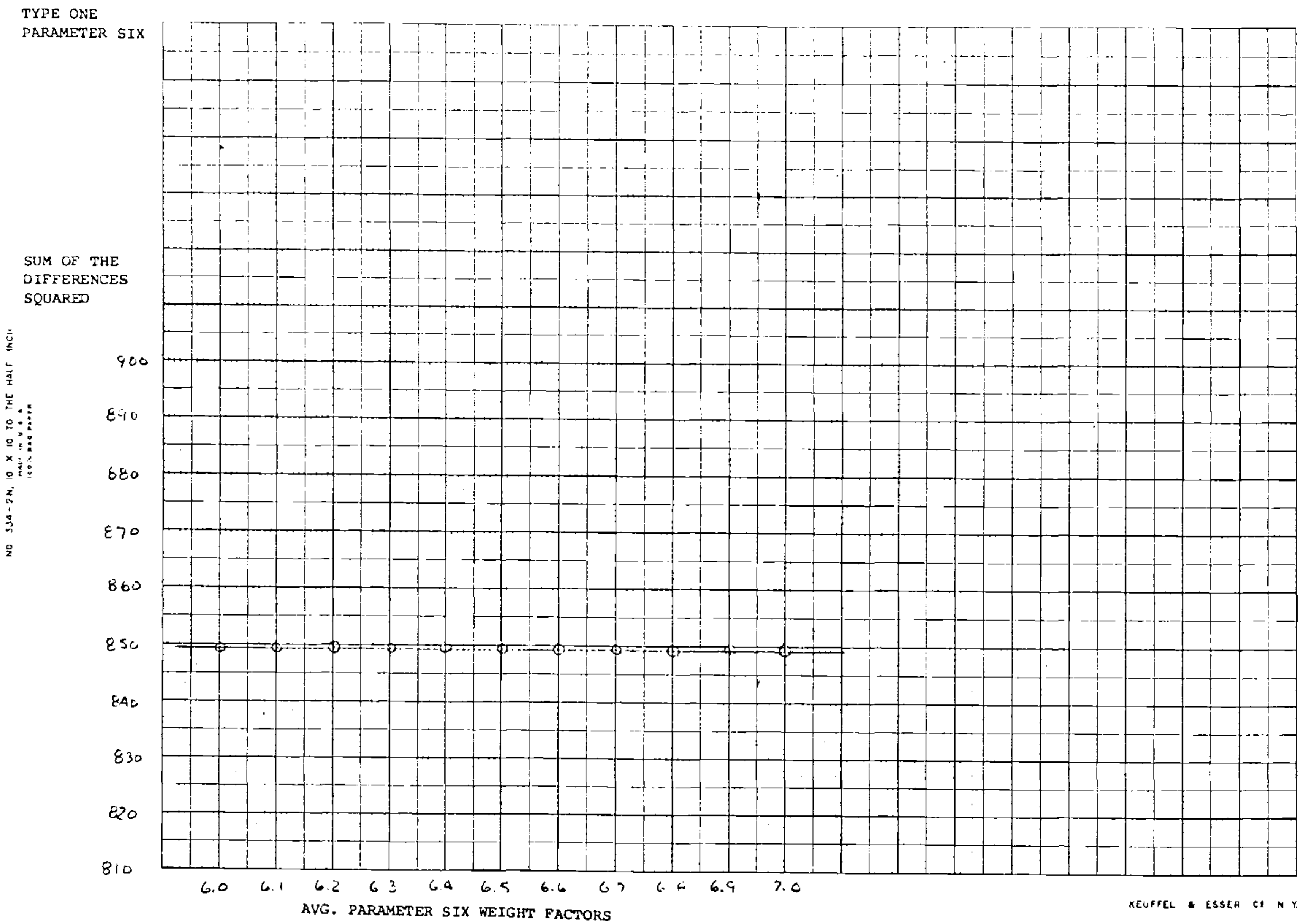

TYPE ONE
PARAMETER TWO
SUM OF THE
DIFFERENCES
SQUARED
900
890
880
870
860
850
840
830
820
810
6.6
6.7
6.8
6.9
7.0
7.1
7.2
7.3
7.4
7.5
7.6
AVG. PARAMETER TWO WEIGHT FACTORS


TYPE ONE
PARAMETER THREE
SUM OF THE
DIFFERENCES
SQUARED
900
890
880
870
860
850
840
830
820
810
7.2
7.3
7.4
7.5
7.6
7.7
7.8
7.9
8.0
8.1
8.2
AVG. PARAMETER THREE WEIGHT FACTORS
NO 334-2N, 10 X 10 TO THE HALF INCH
KEUFFEL & ESSER CO. N.Y.

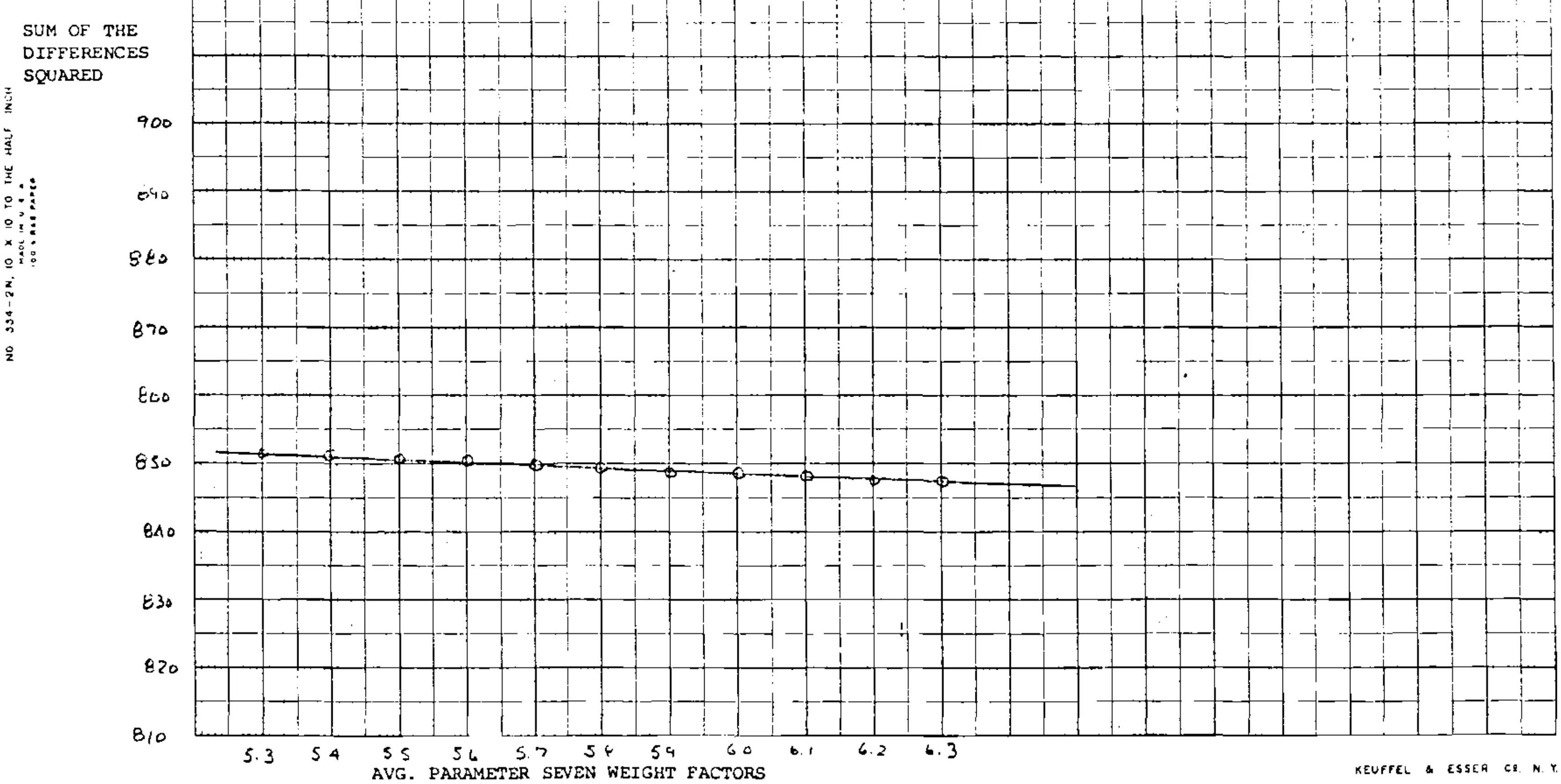


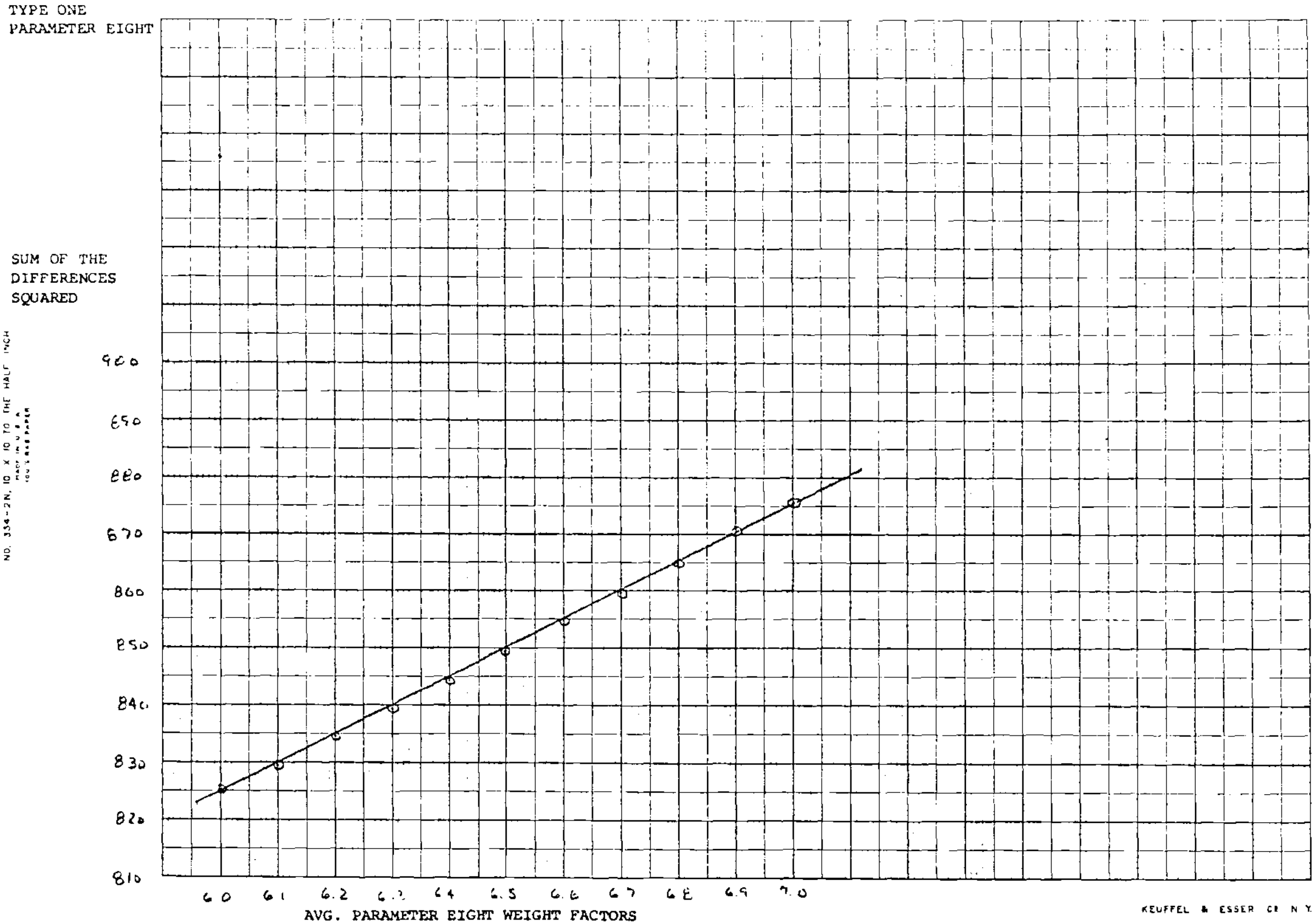
TYPE ONE
PARAMETER FOUR
SUM OF THE
DIFFERENCES
SQUARED
900
880
870
850
840
820
810
6.7
7.1
7.2
7.4
7.5
7.7
AVG. PARAMETER FOUR WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.


TYPE ONE
PARAMETER FIVE
SUM OF THE DIFFERENCES SQUARED
900
890
880
870
860
850
840
830
820
810
7.2
7.3
7.4
7.5
7.6
7.7
7.8
7.9
8.0
8.1
8.2
AVG. PARAMETER FIVE WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.

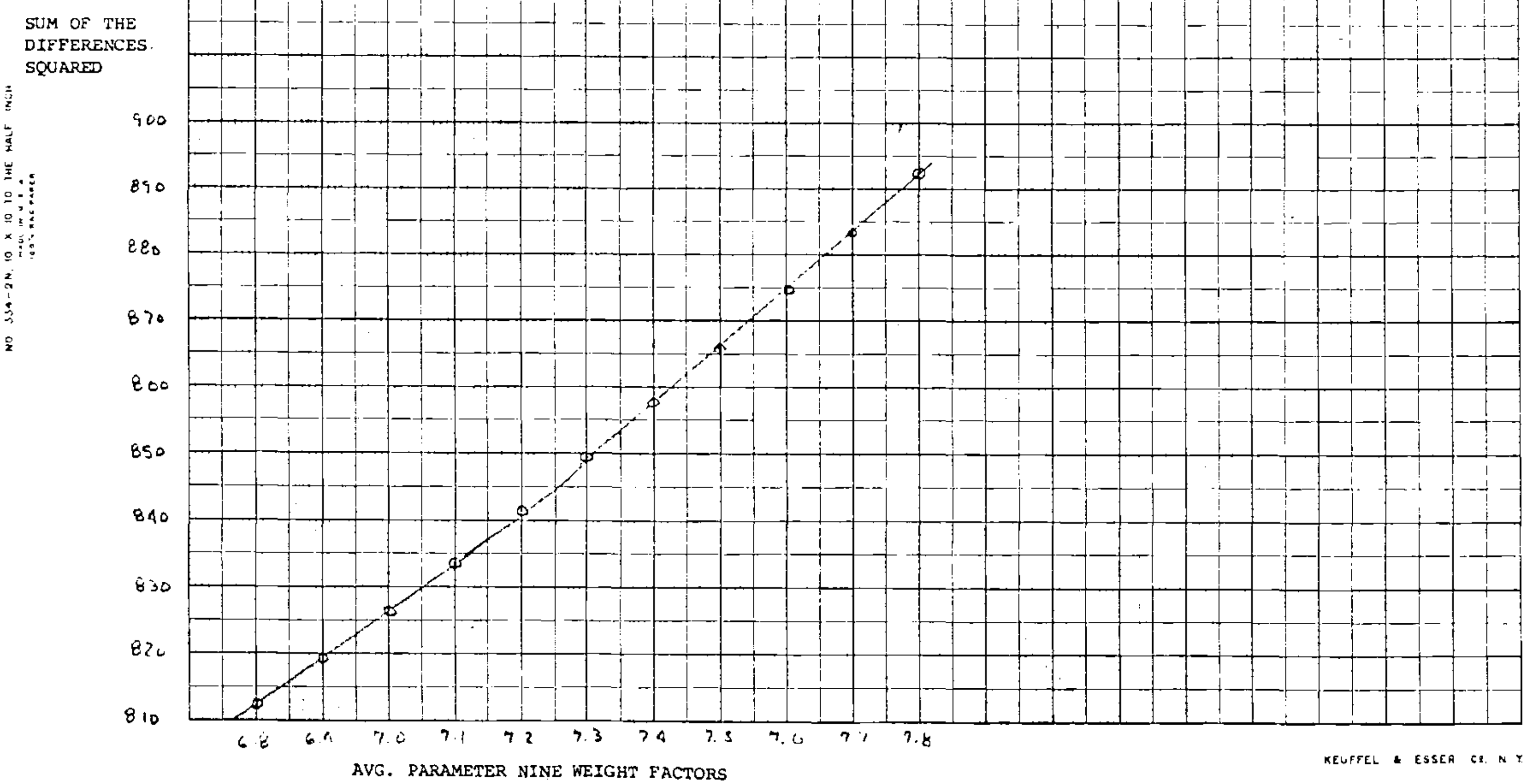

TYPE ONE
PARAMETER SIX
SUM OF THE
DIFFERENCES
SQUARED
900
890
880
870
860
850
840
830
820
810
6.0
6.1
6.2
6.3
6.4
6.5
6.6
6.7
6.8
6.9
7.0
AVG. PARAMETER SIX WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.

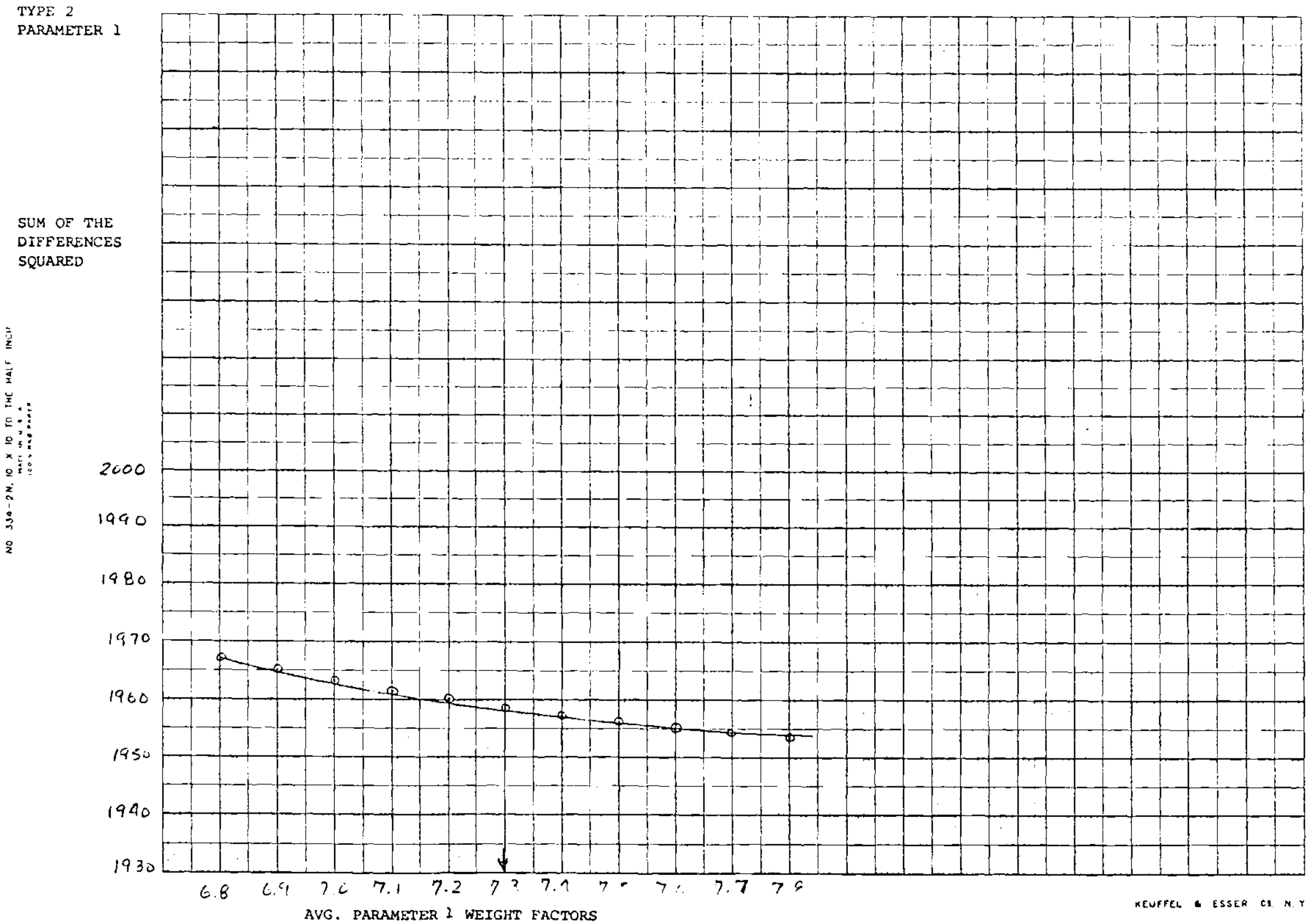
TYPE ONE
PARAMETER SEVEN

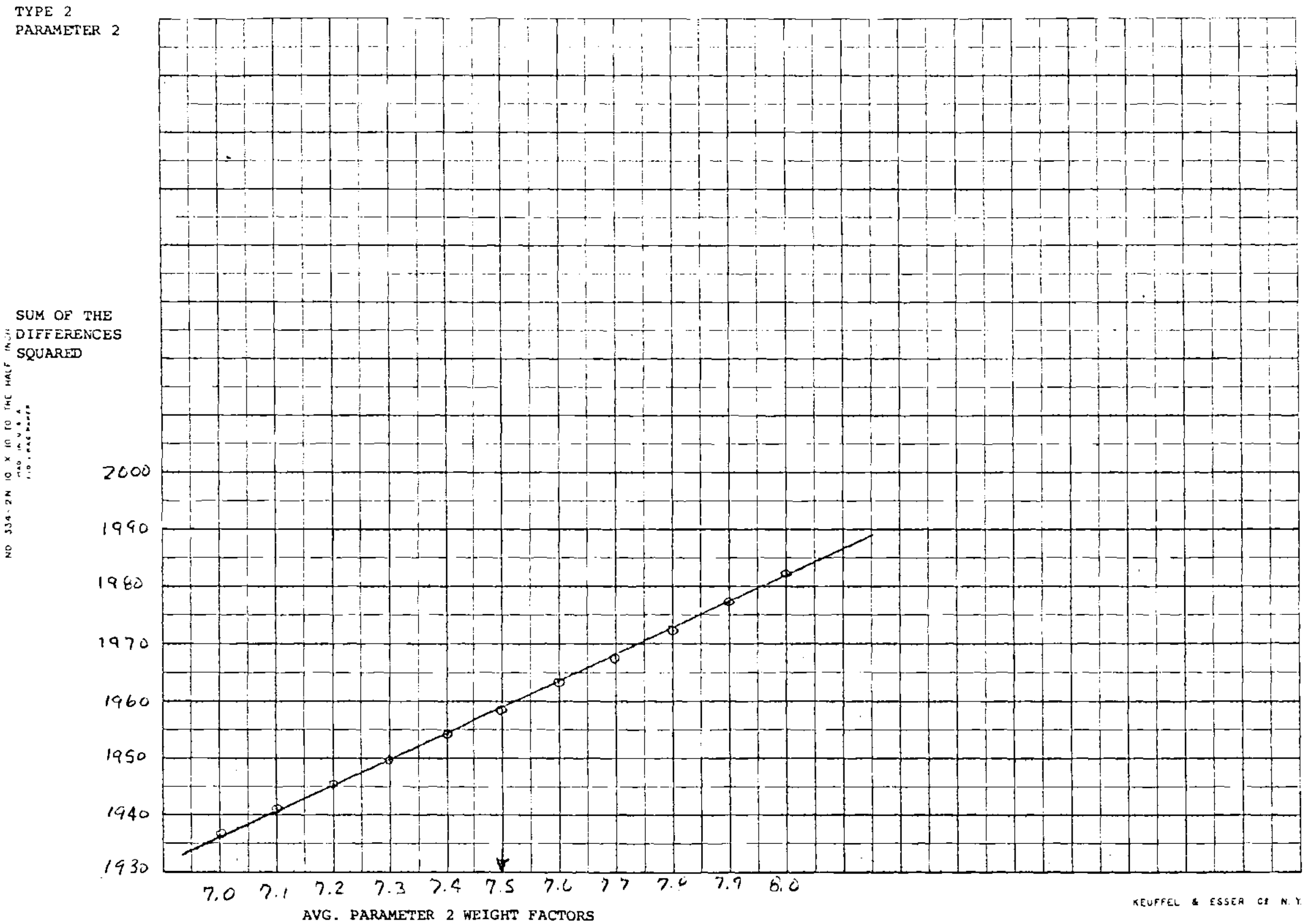



TYPE ONE
PARAMETER EIGHT
SUM OF THE
DIFFERENCES
SQUARED
AVG. PARAMETER EIGHT WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.

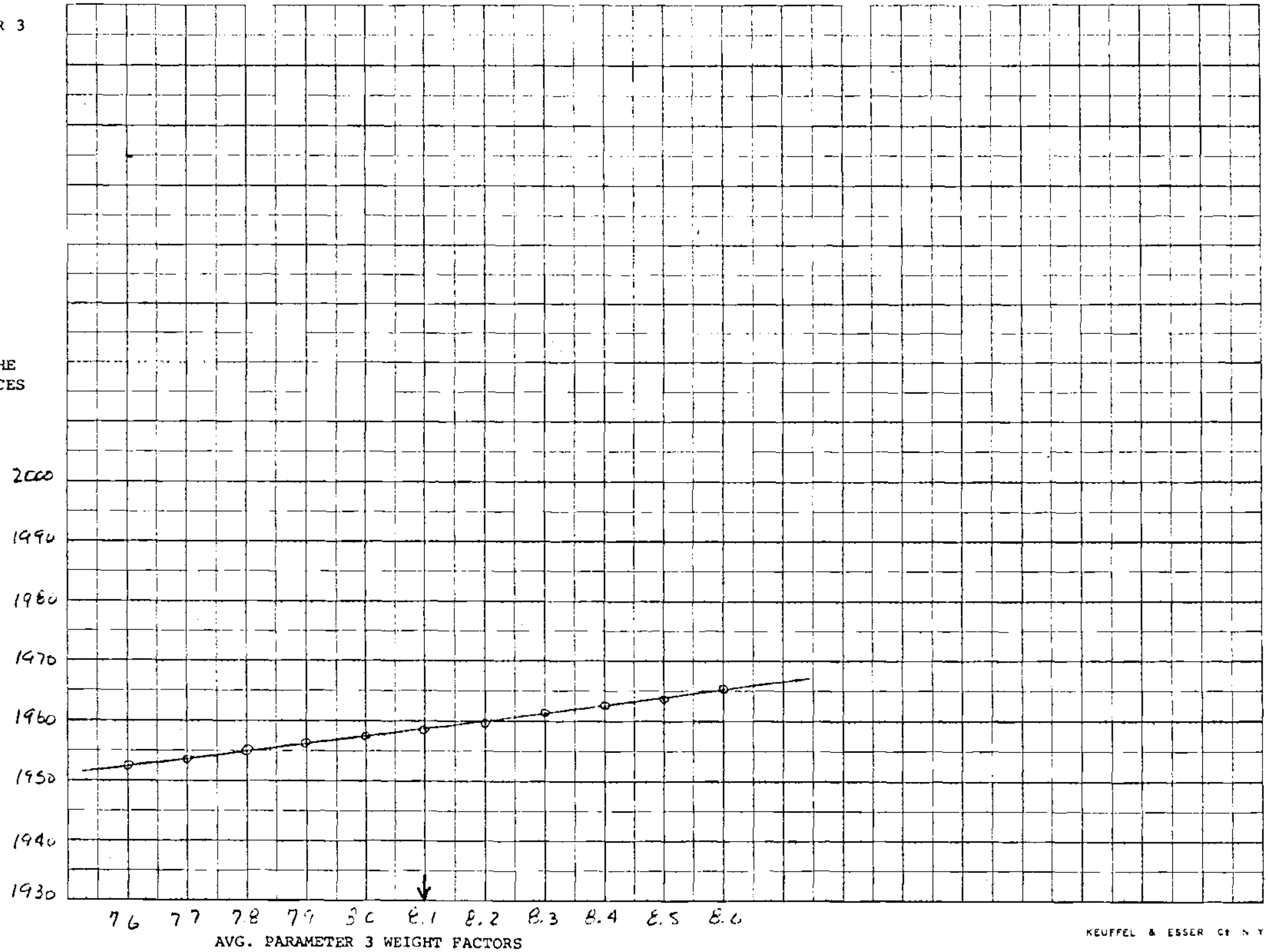
TYPE ONE
PARAMETER NINE



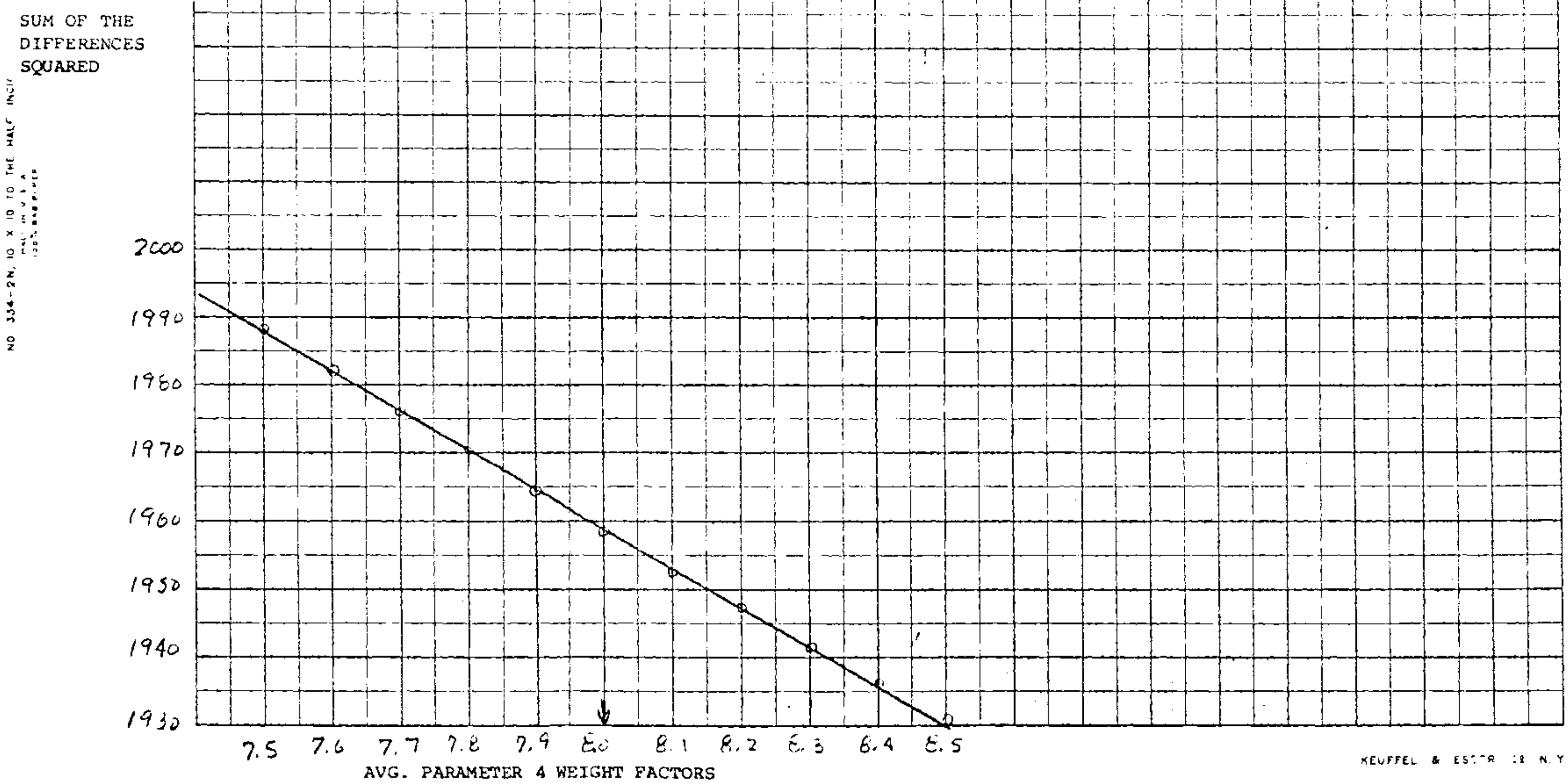

TYPE 2
PARAMETER 1
SUM OF THE
DIFFERENCES
SQUARED
2000
1990
1980
1970
1960
1950
1940
1930
6.8
7.1
7.2
7.7
AVG. PARAMETER 1 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.

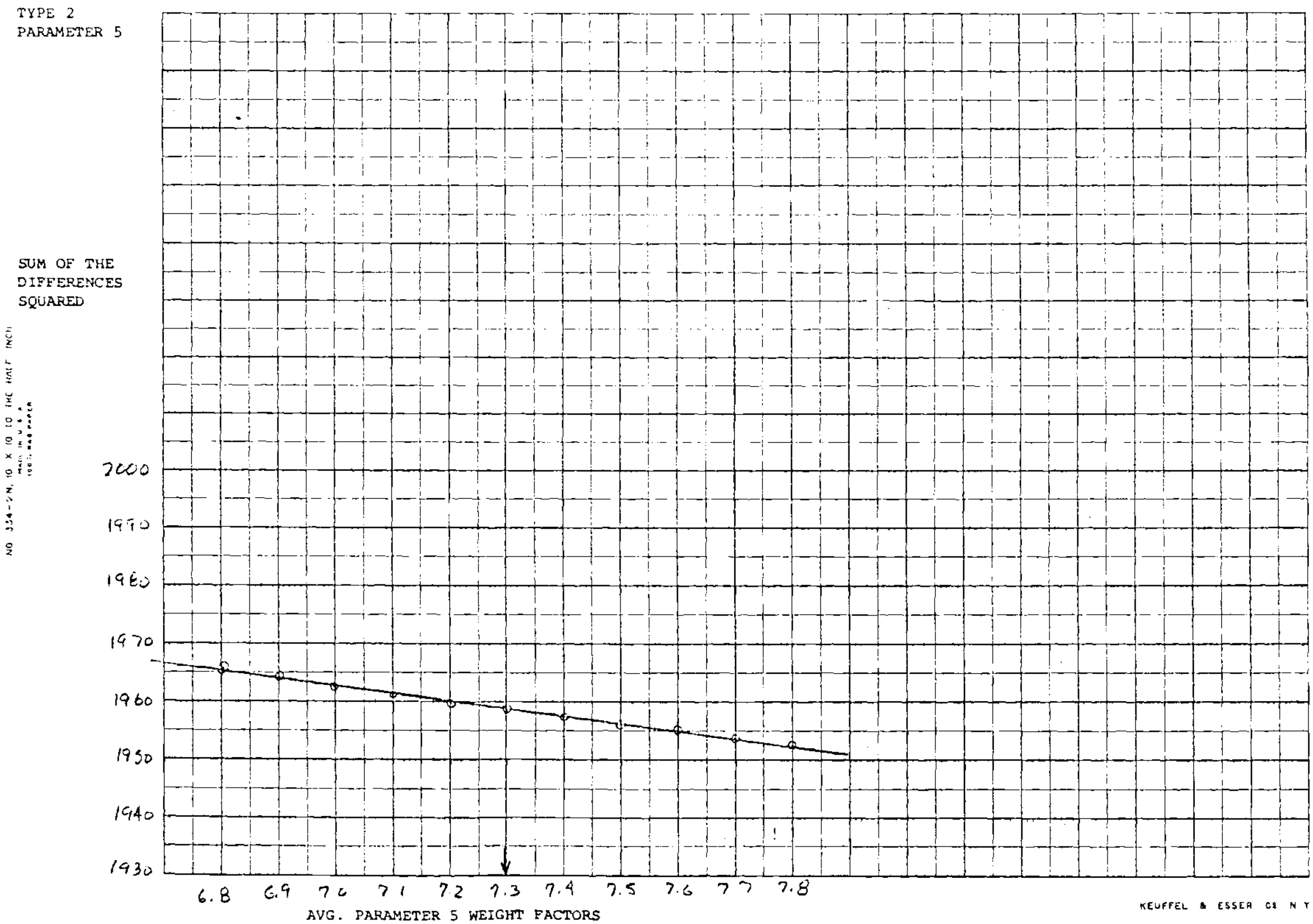

TYPE 2
PARAMETER 2
SUM OF THE
DIFFERENCES
SQUARED
2000
1990
1980
1970
1960
1950
1940
1930
7.0
7.1
7.2
7.3
7.4
7.5
AVG. PARAMETER 2 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.

TYPE 2
PARAMETER 3



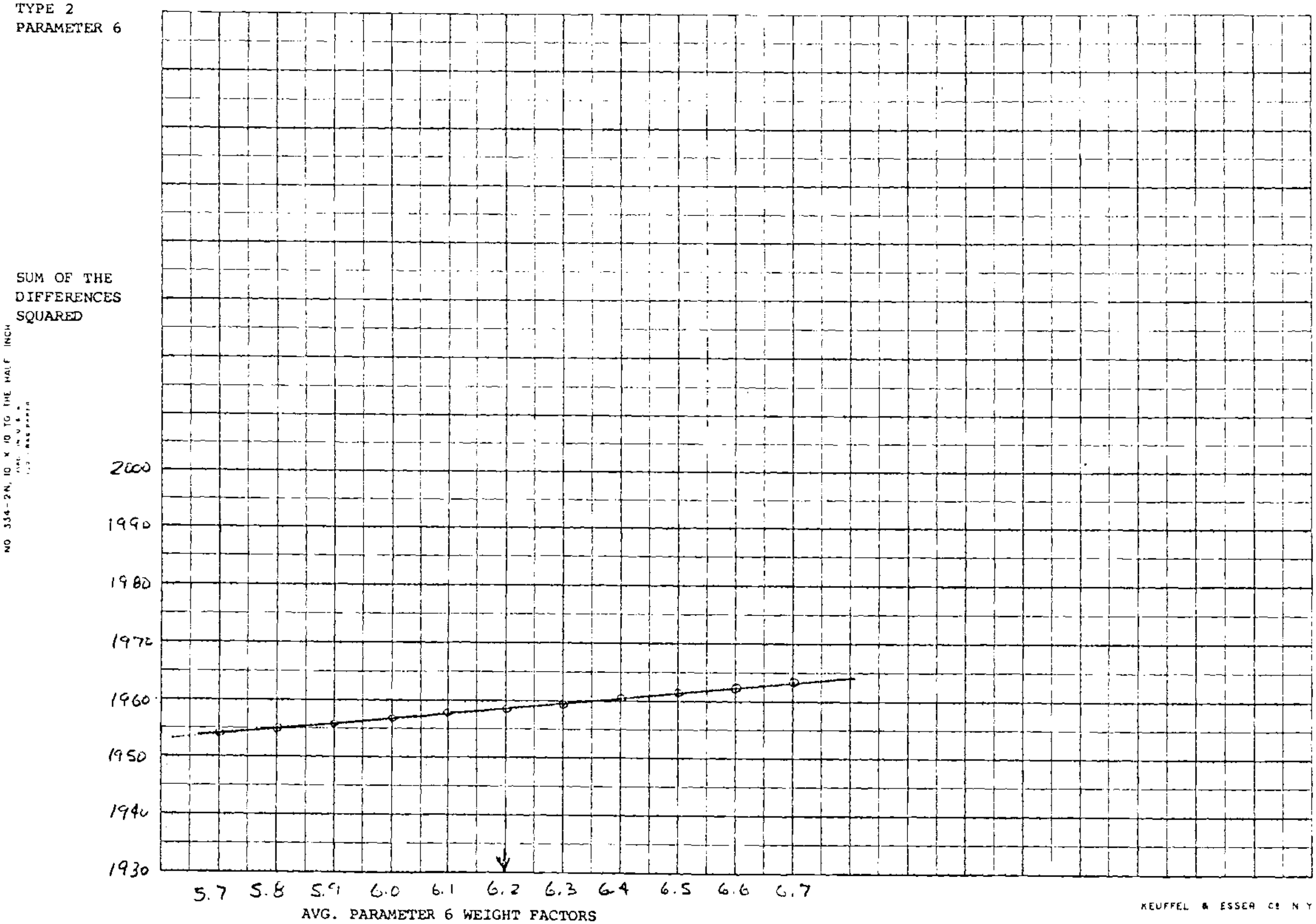
TYPE 2
PARAMETER 4

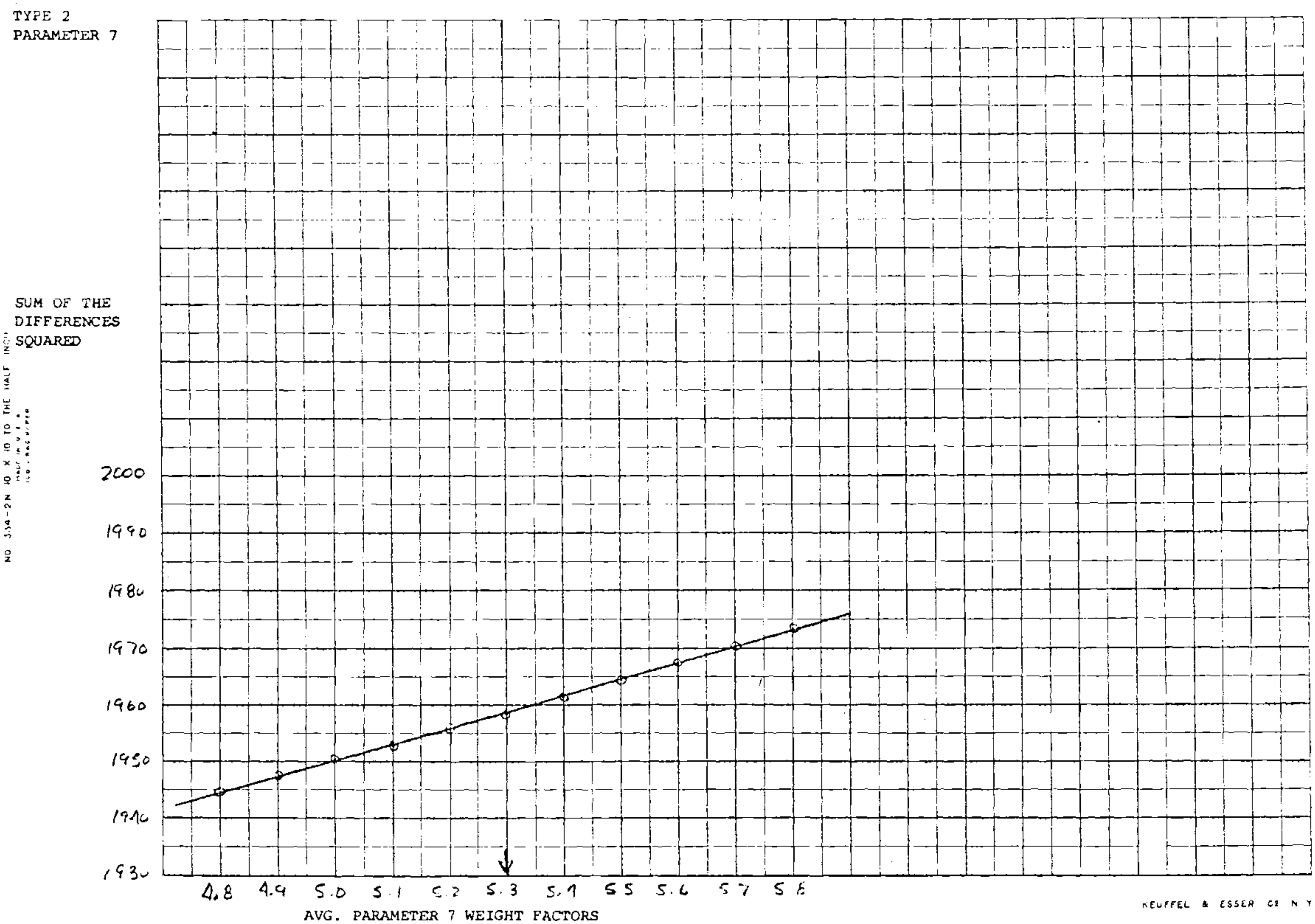




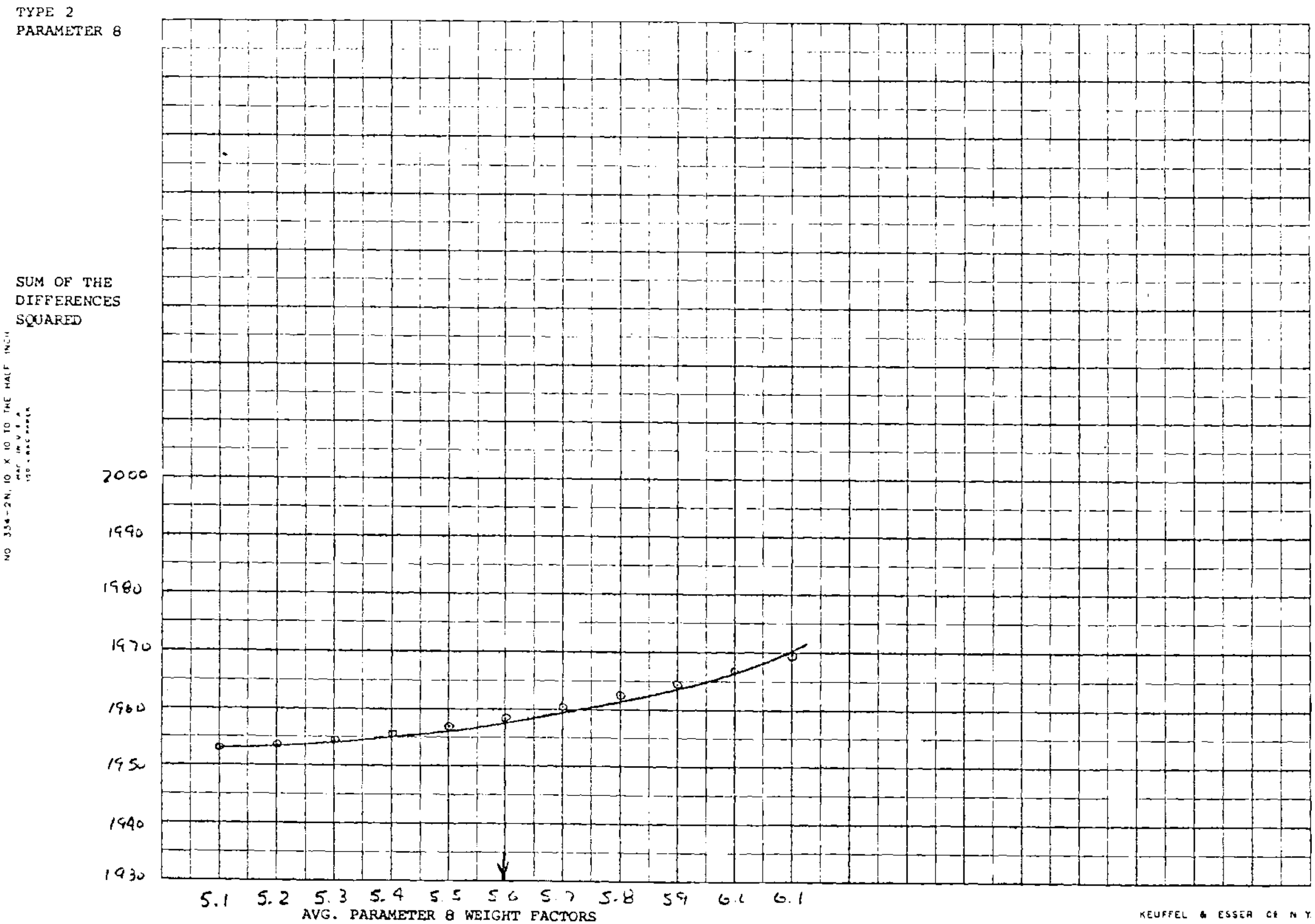
TYPE 2
PARAMETER 5
SUM OF THE
DIFFERENCES
SQUARED
2000
1990
1980
1970
1960
1950
1940
1930
6.8
6.9
7.0
7.1
7.2
7.3
7.4
7.5
7.6
7.7
7.8
AVG. PARAMETER 5 WEIGHT FACTORS

TYPE 2
PARAMETER 6





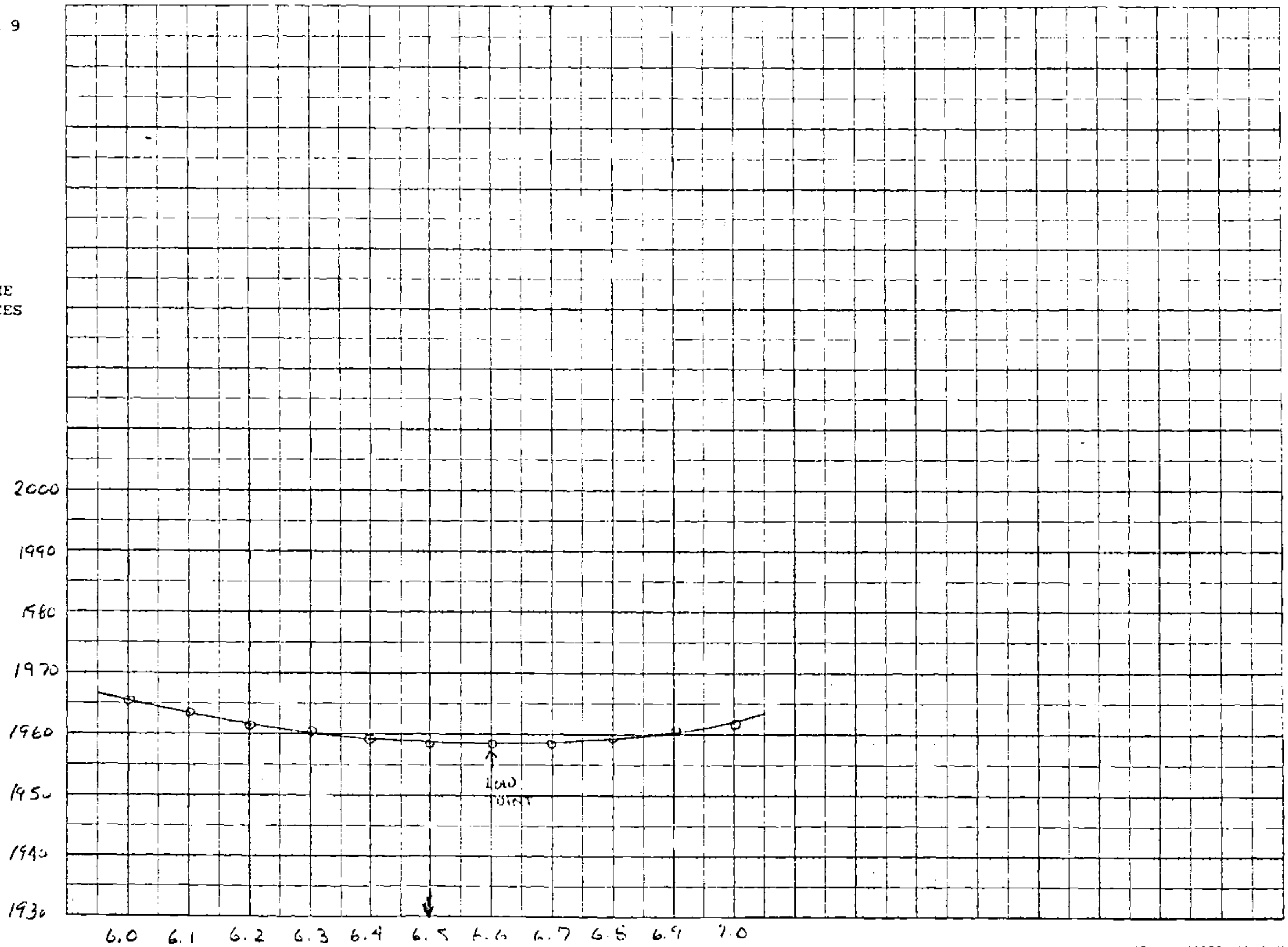
TYPE 2
PARAMETER 7
SUM OF THE DIFFERENCES SQUARED
2000
1990
1980
1970
1960
1950
1940
1930
4.8
4.9
5.0
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
AVG. PARAMETER 7 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.



TYPE 2
PARAMETER 8
SUM OF THE
DIFFERENCES
SQUARED
2000
1990
1980
1970
1960
1950
1940
1930
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
5.9
6.0
6.1
AVG. PARAMETER 8 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.

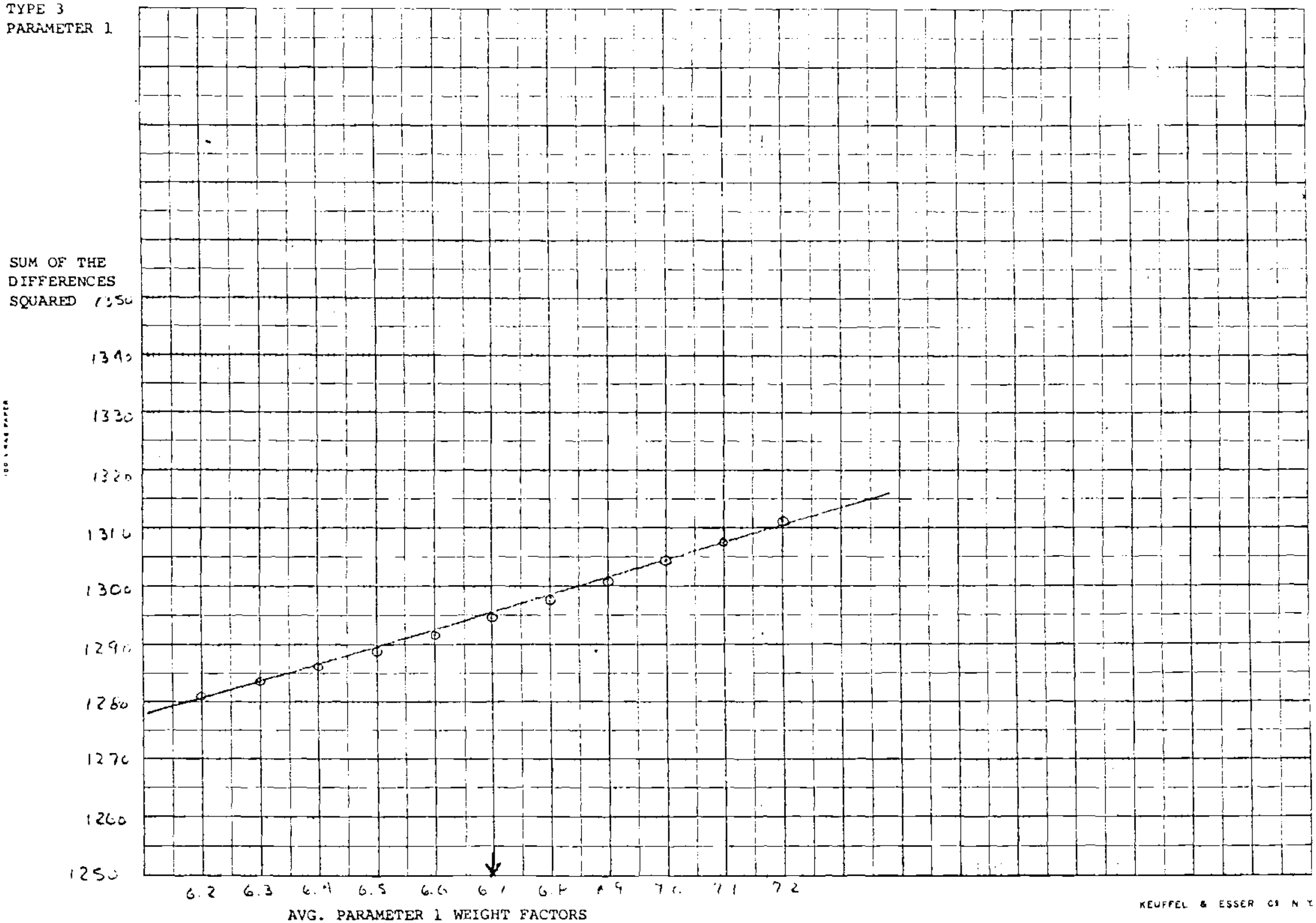
TYPE 2
PARAMETER 9

SUM OF THE
DIFFERENCES
SQUARED

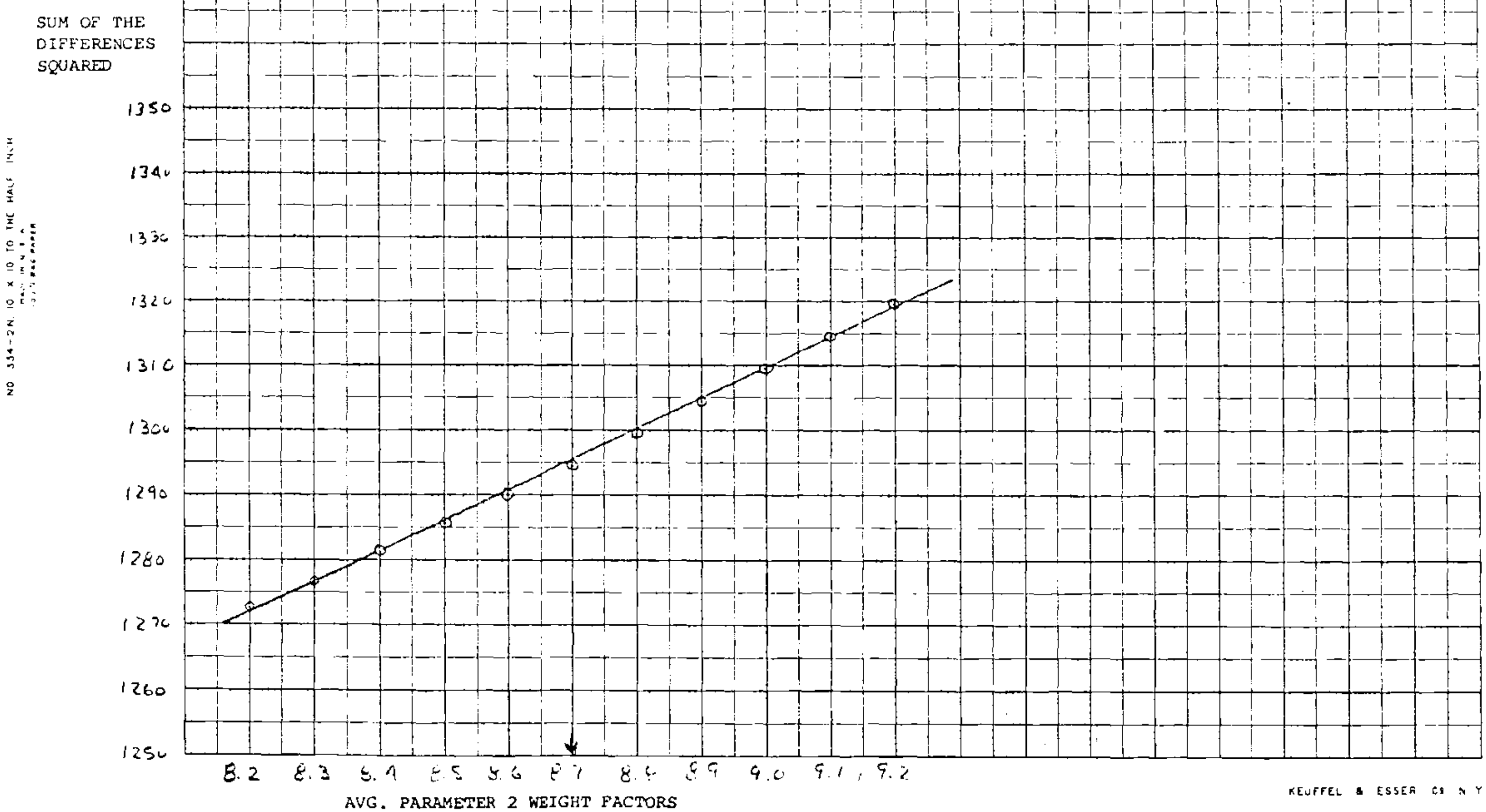


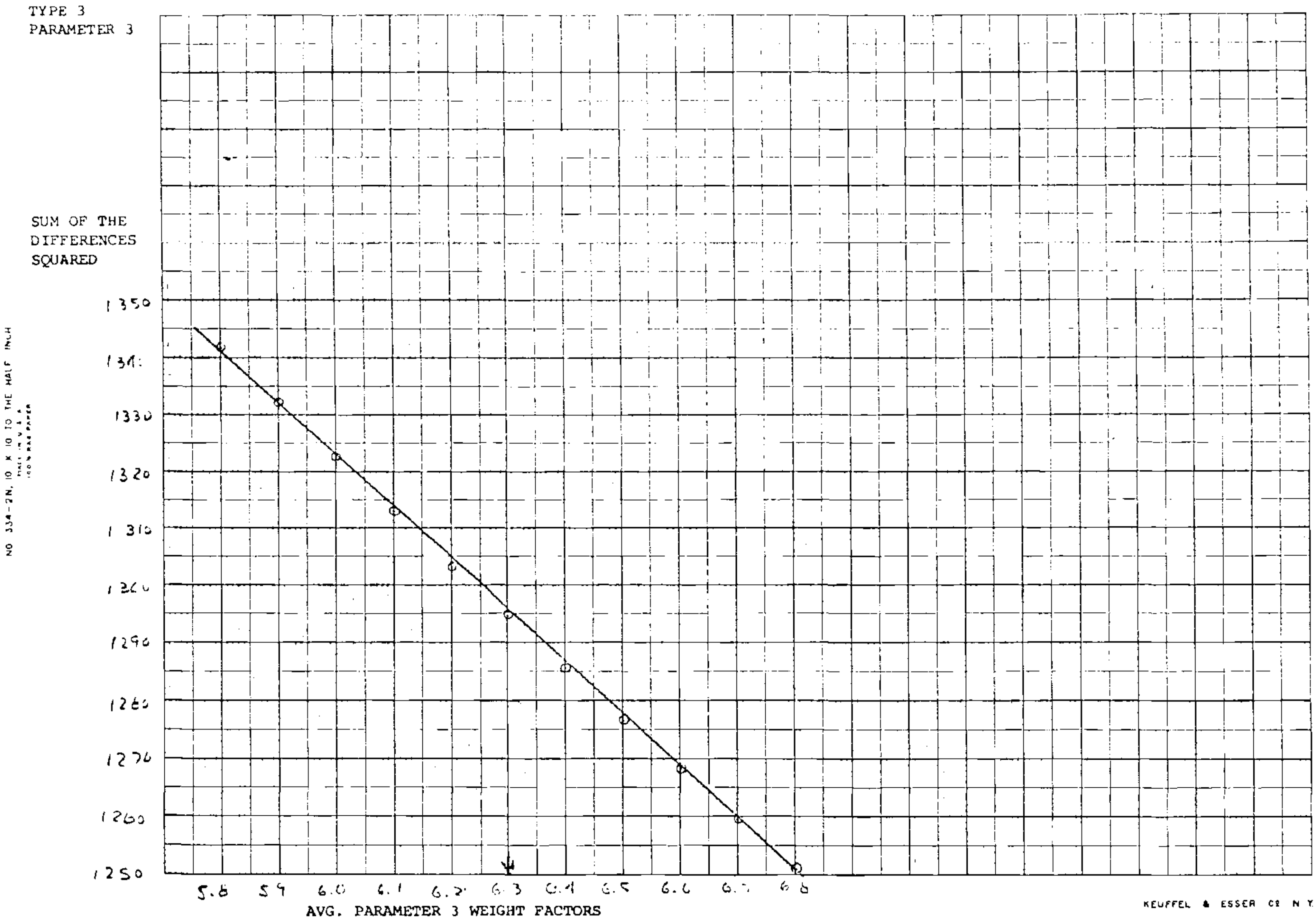
AVG. PARAMETER 9 WEIGHT FACTORS

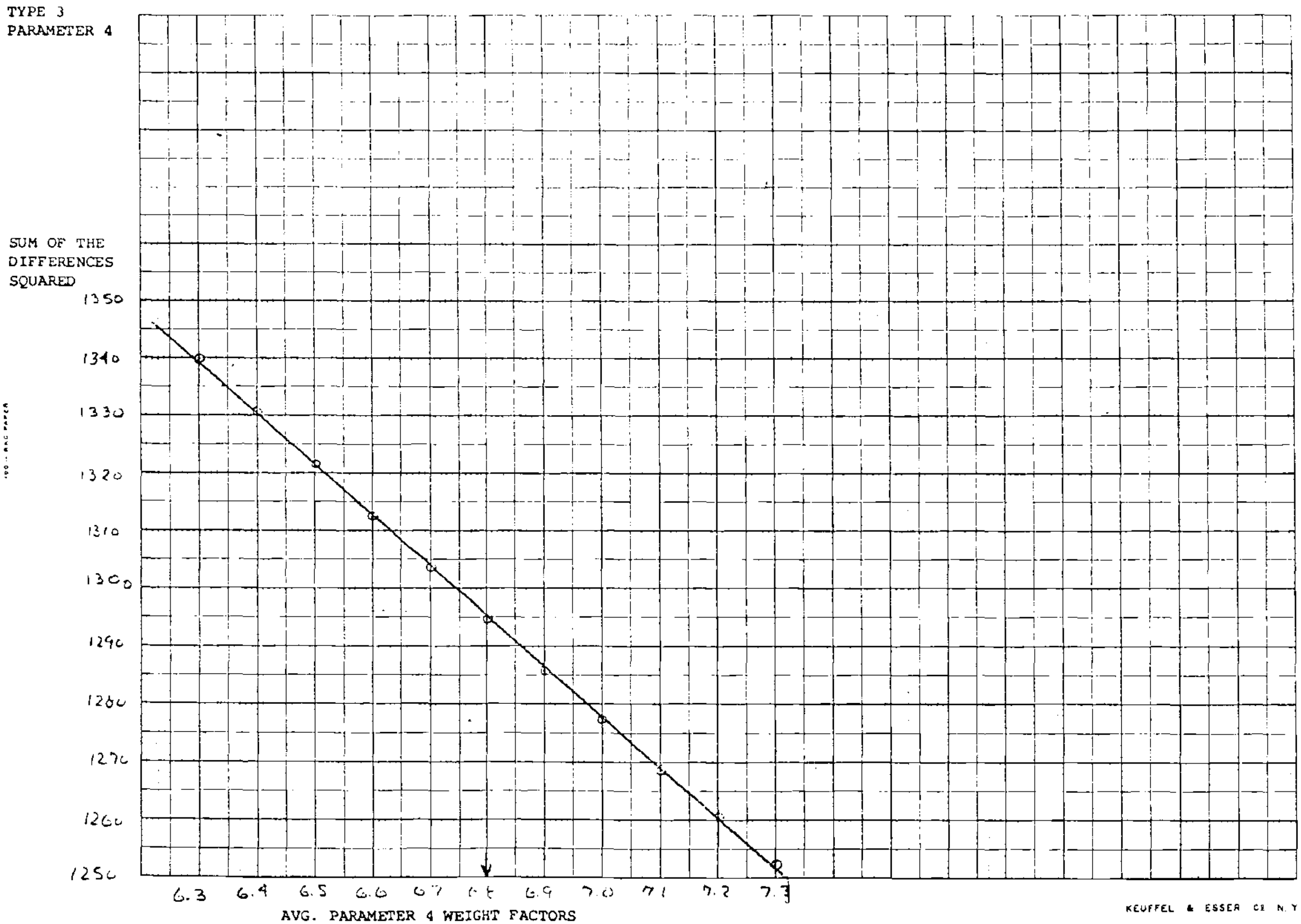
TYPE 3
PARAMETER 1

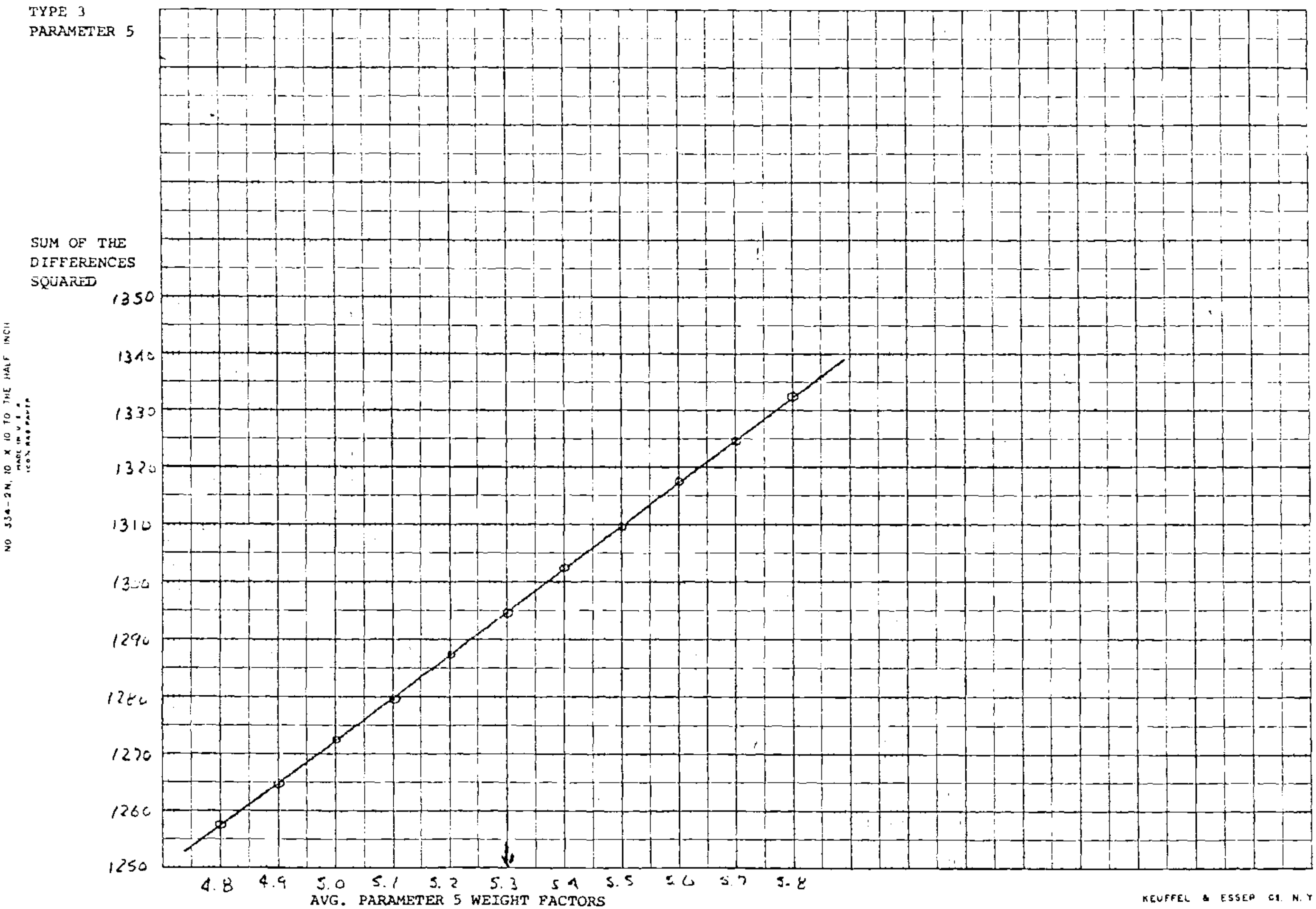


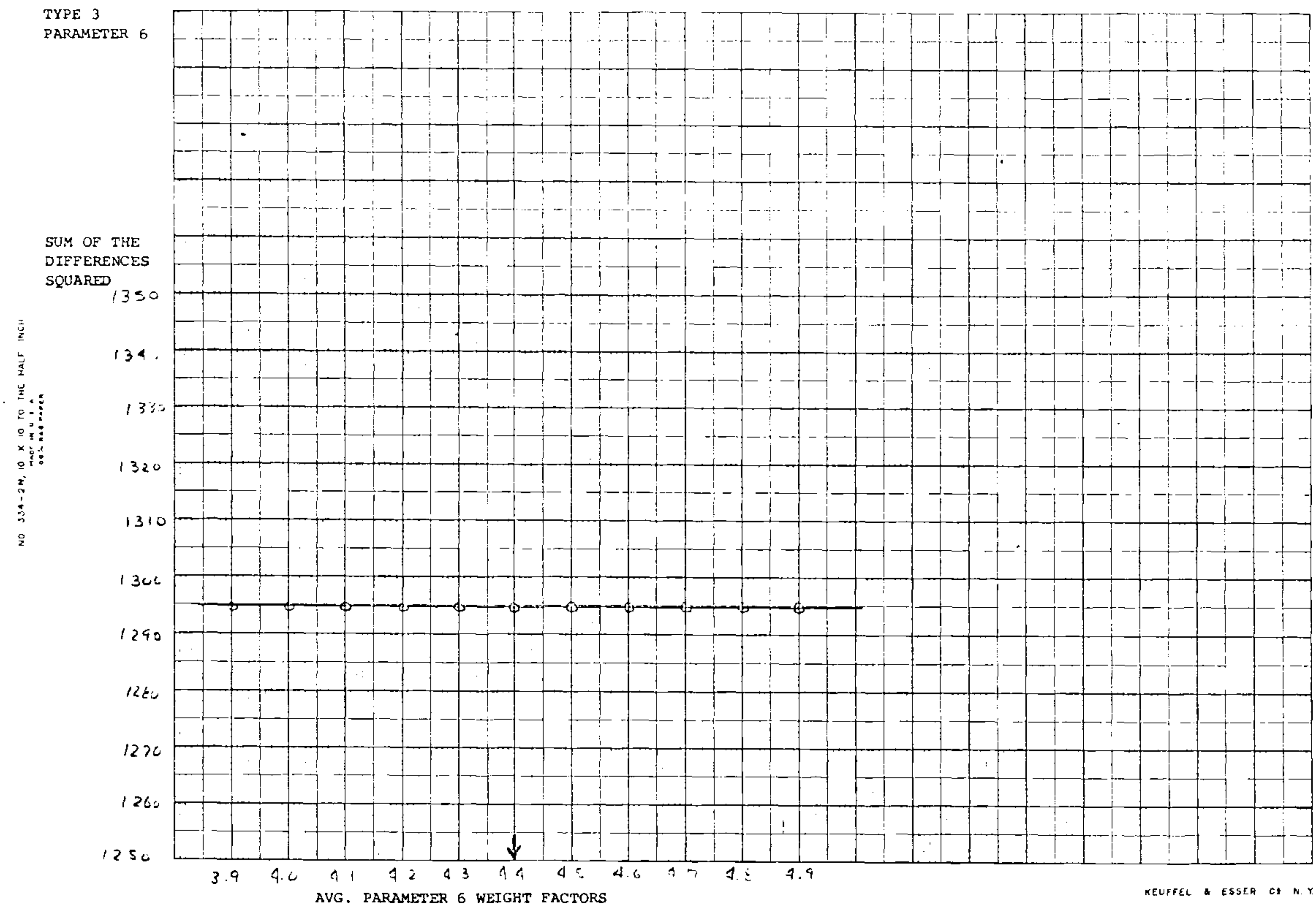
TYPE 3
PARAMETER 2




TYPE 3
PARAMETER 3
SUM OF THE DIFFERENCES SQUARED
1350
1330
1320
1310
1290
1270
1260
1250
5.8
5.9
6.0
6.1
6.3
6.5
6.6
6.8
AVG. PARAMETER 3 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.

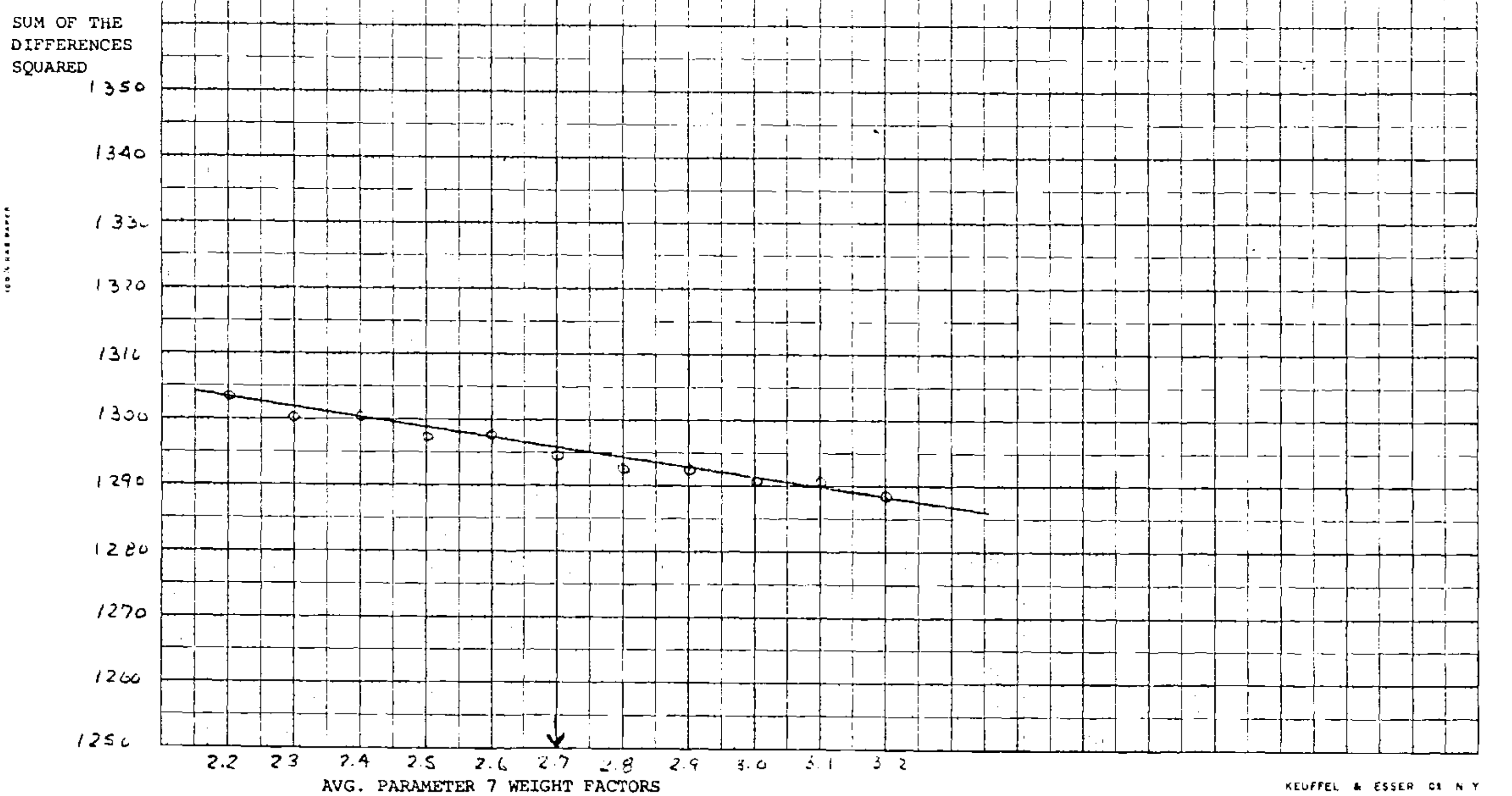

TYPE 3
PARAMETER 4
SUM OF THE
DIFFERENCES
SQUARED
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
6.3
6.4
6.5
6.6
6.7
6.9
7.0
7.1
7.2
7.3
AVG. PARAMETER 4 WEIGHT FACTORS


TYPE 3
PARAMETER 5
SUM OF THE DIFFERENCES SQUARED
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
4.8
4.9
5.0
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
AVG. PARAMETER 5 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.

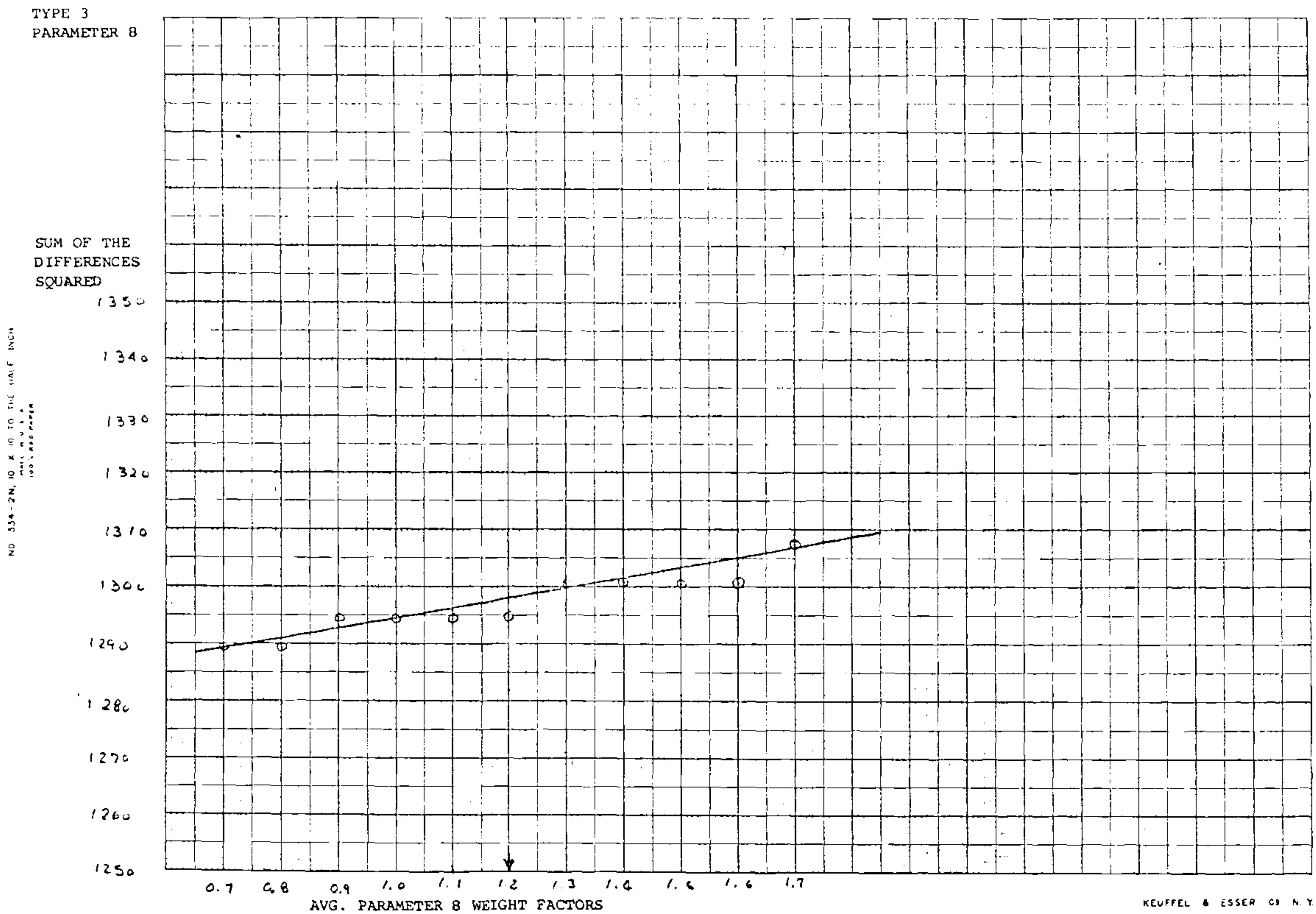


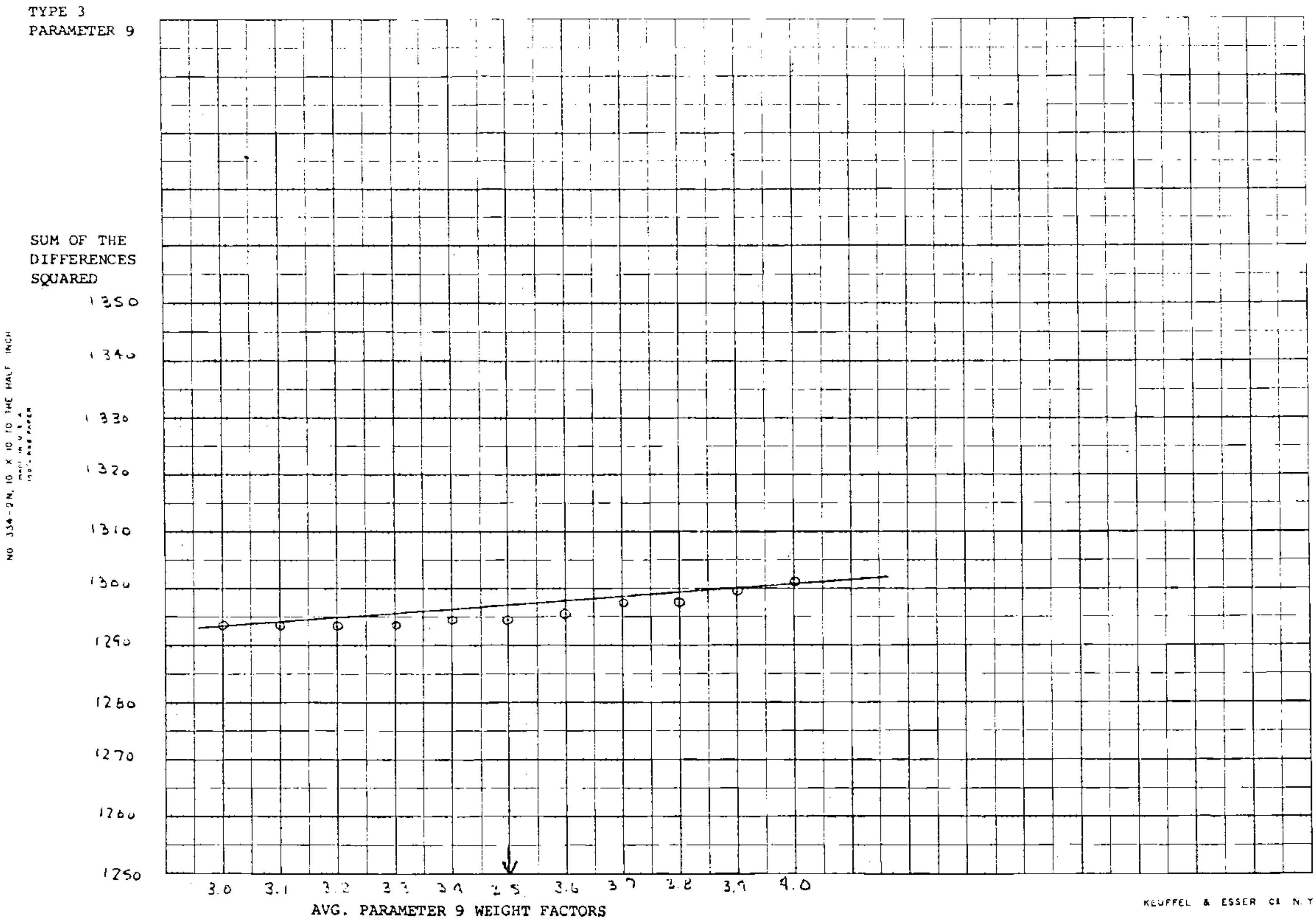
TYPE 3
PARAMETER 6
SUM OF THE
DIFFERENCES
SQUARED
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
3.9
4.0
4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8
4.9
AVG. PARAMETER 6 WEIGHT FACTORS
NO 334-2M, 10 X 10 TO THE HALF INCH
KEUFFEL & ESSER CO. N.Y.

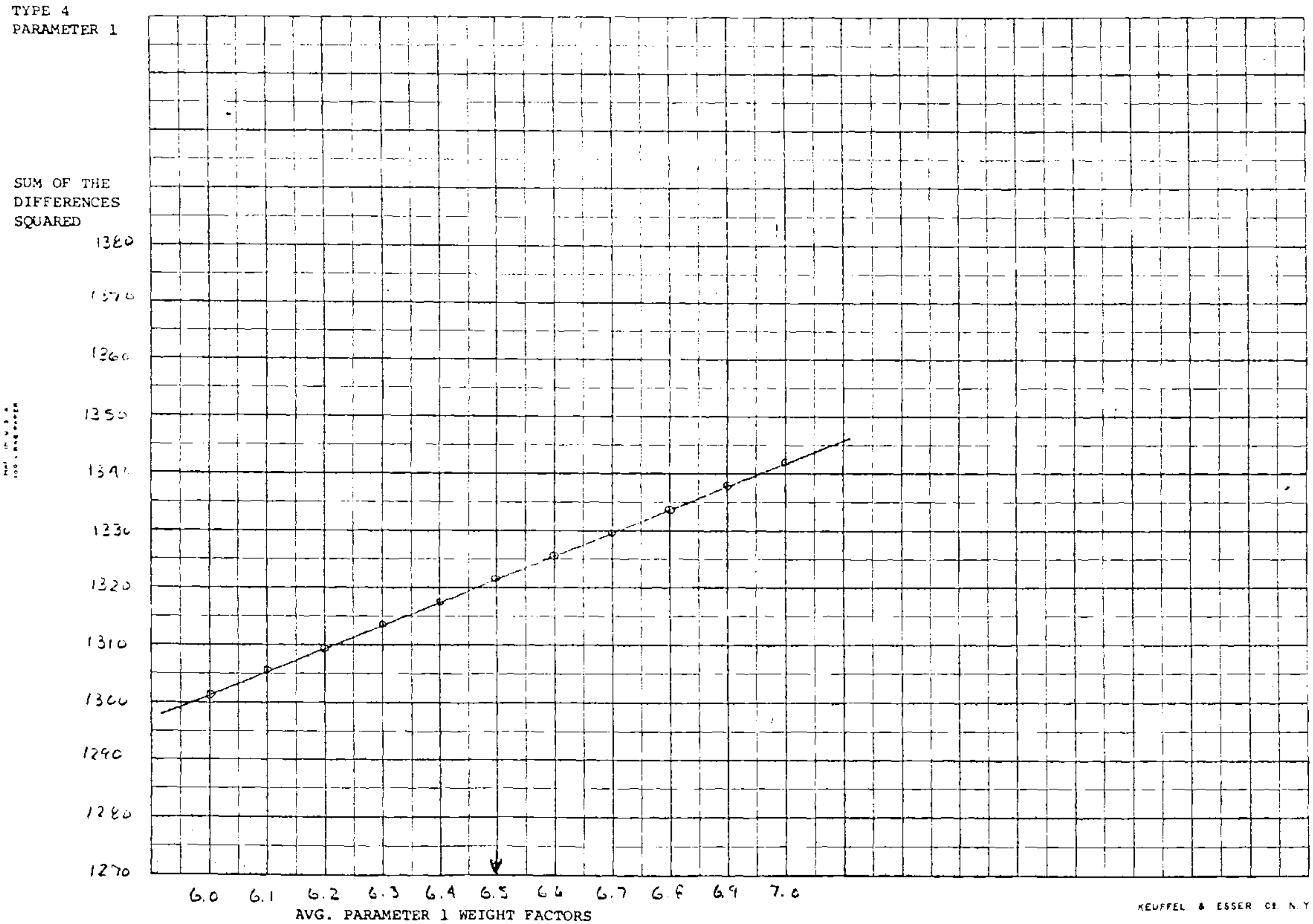
TYPE 3
PARAMETER 7



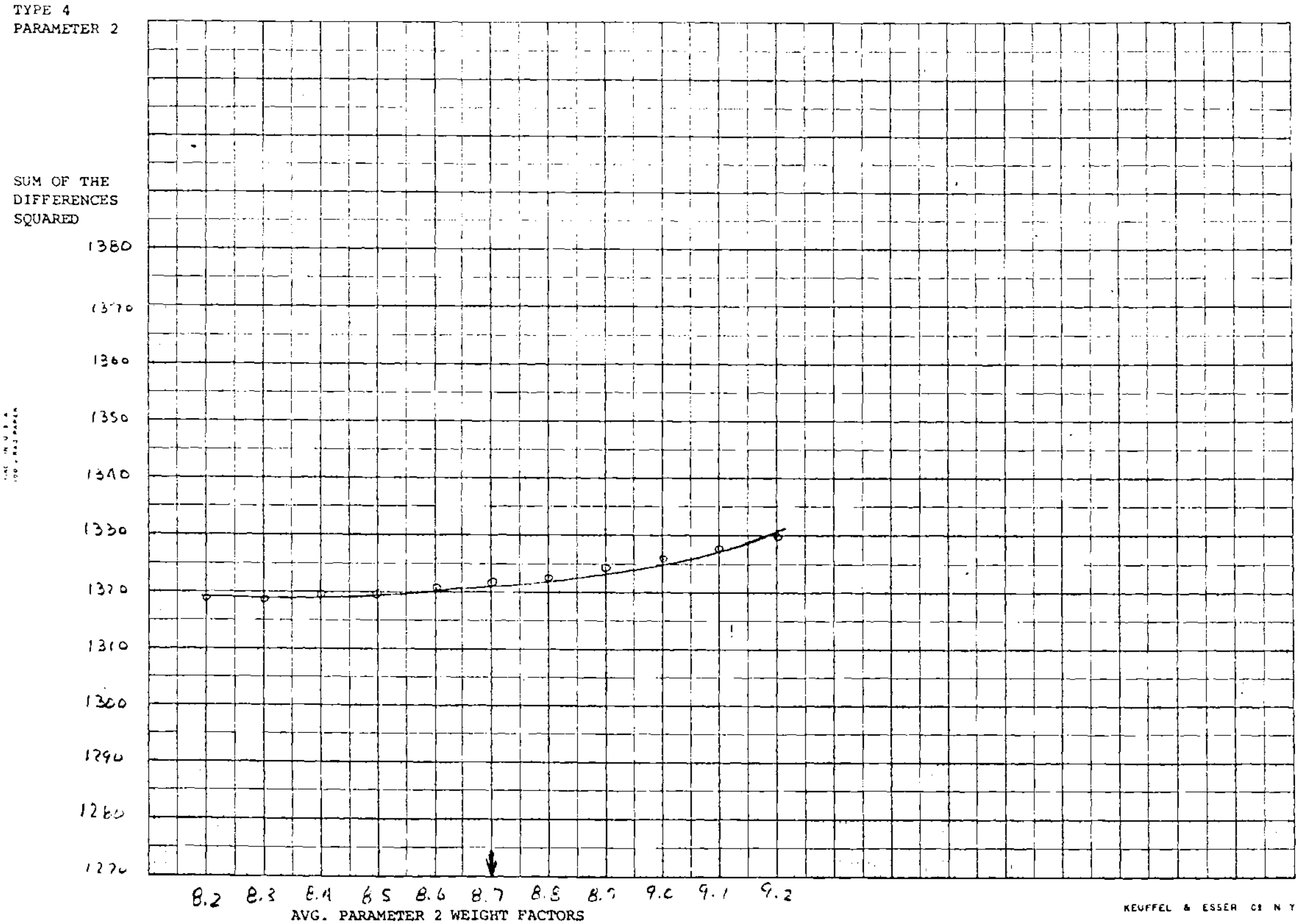
KEUFFEL & ESSER CO. N.Y.

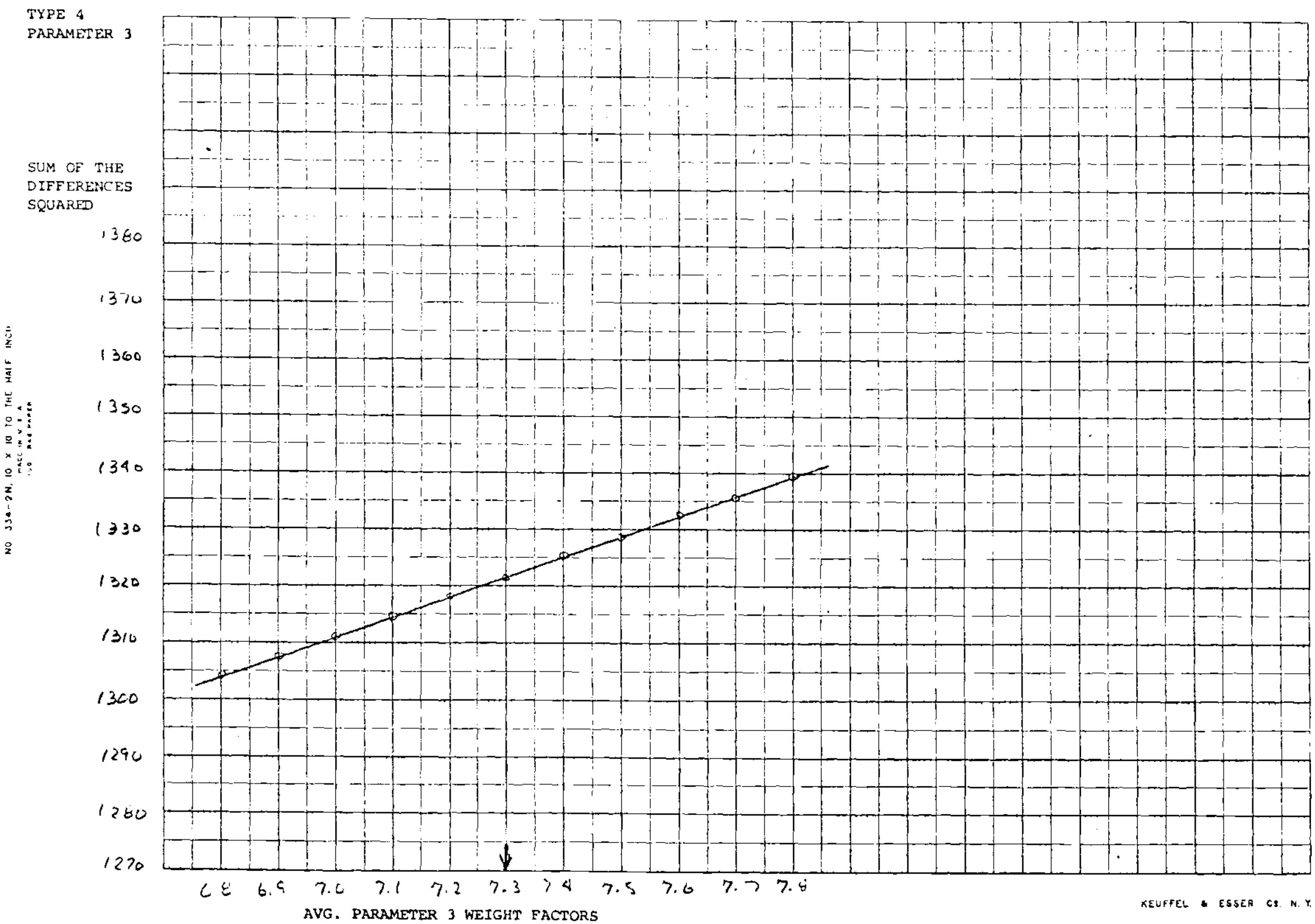

TYPE 3
PARAMETER 8
SUM OF THE
DIFFERENCES
SQUARED
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
AVG. PARAMETER 8 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.

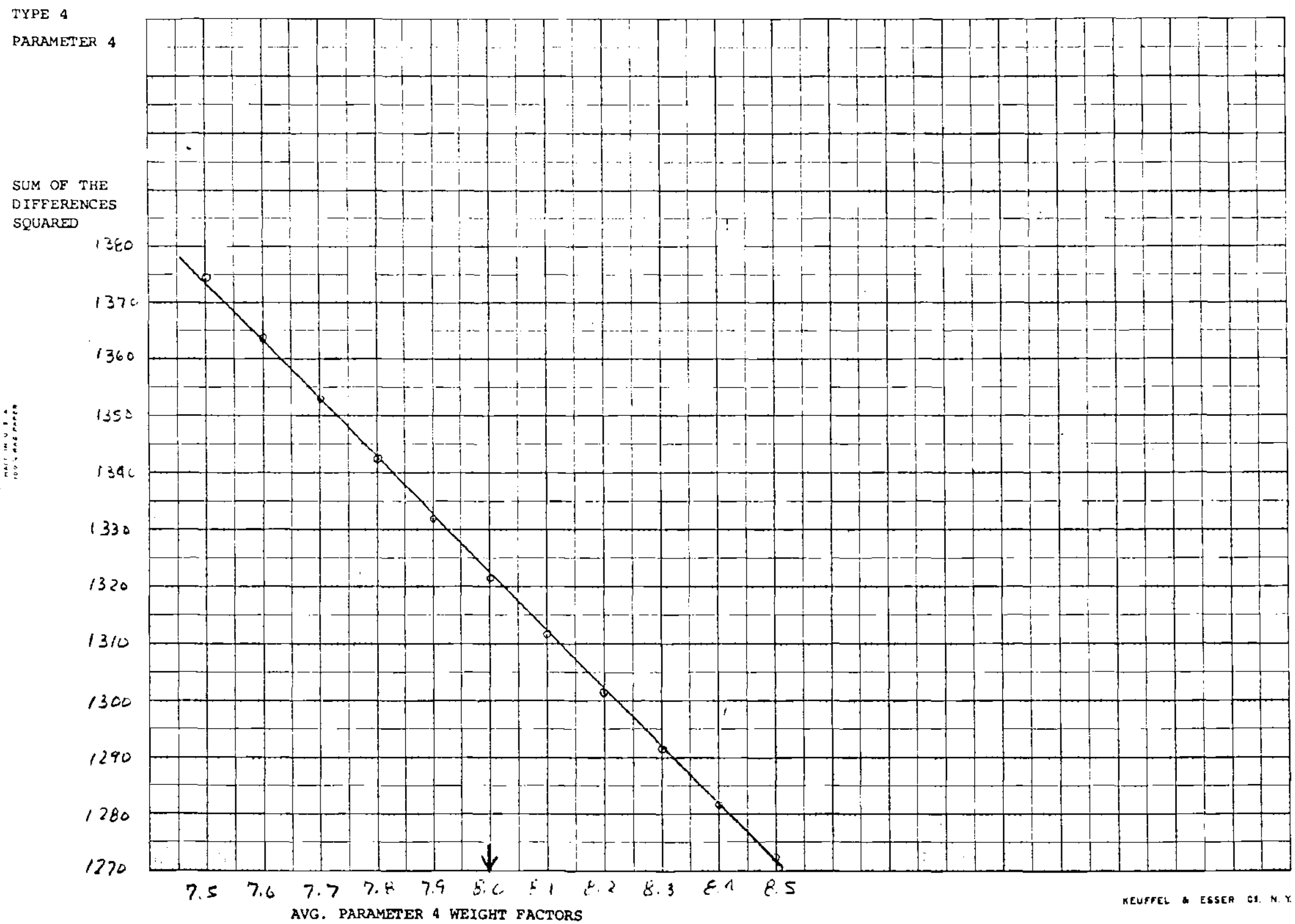

TYPE 3
PARAMETER 9
SUM OF THE
DIFFERENCES
SQUARED
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
3.0
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4.0
AVG. PARAMETER 9 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.
NO 334-2N, 10 X 10 TO THE HALF INCH

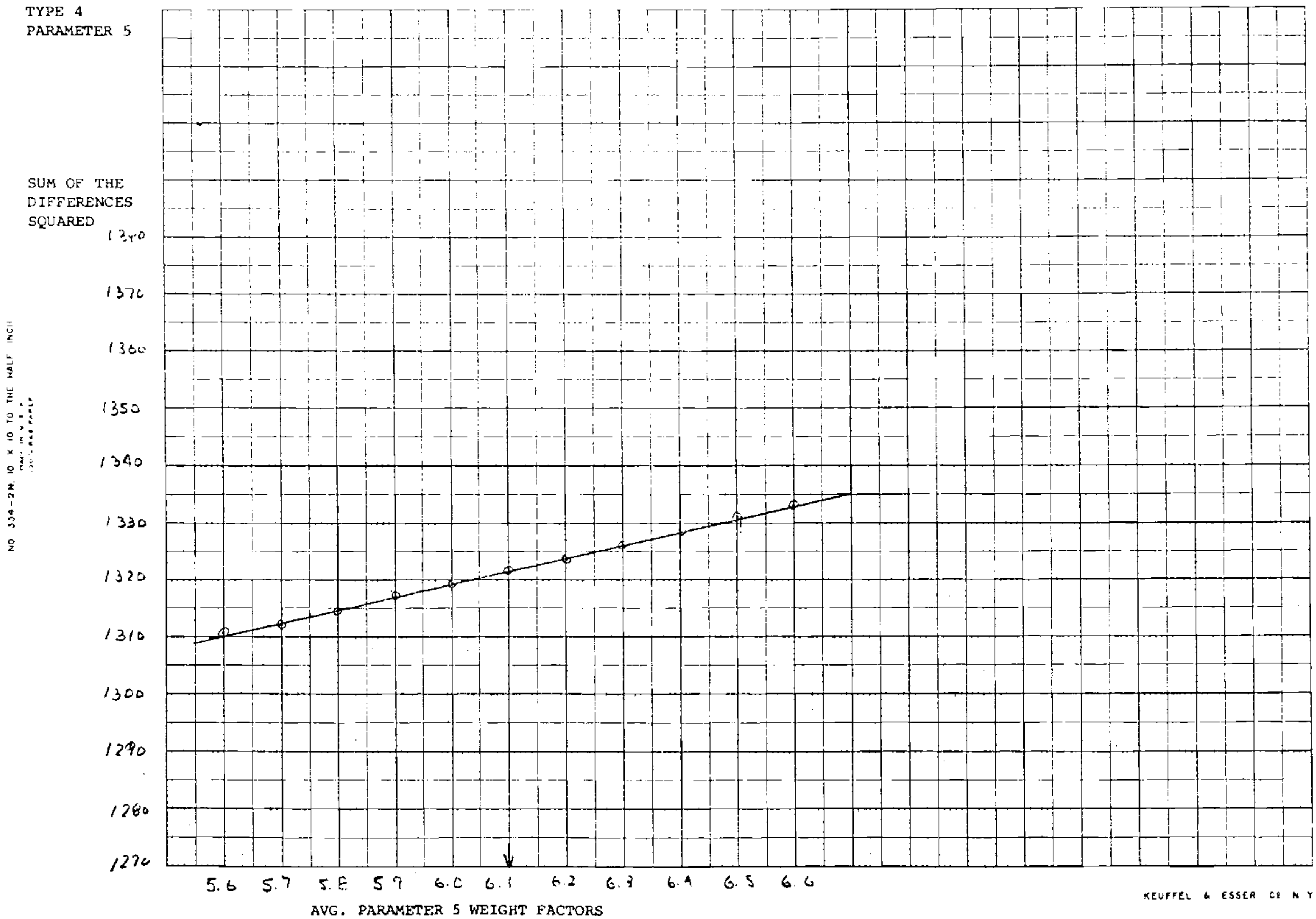


TYPE 4
PARAMETER 1
SUM OF THE DIFFERENCES SQUARED
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
6.0
6.1
6.2
6.3
6.4
6.5
6.6
6.7
6.8
6.9
7.0
AVG. PARAMETER 1 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.


TYPE 4
PARAMETER 2
SUM OF THE DIFFERENCES SQUARED
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
8.2
8.3
8.4
8.5
8.6
8.7
8.8
8.9
9.0
9.1
9.2
AVG. PARAMETER 2 WEIGHT FACTORS
KEUFFEL & ESSER CO N Y


TYPE 4
PARAMETER 3
SUM OF THE
DIFFERENCES
SQUARED
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
6.8
6.9
7.0
7.1
7.2
7.3
7.4
7.5
7.6
7.7
7.8
AVG. PARAMETER 3 WEIGHT FACTORS
NO 334-2N, 10 X 10 TO THE HALF INCH
KEUFFEL & ESSER CO. N. Y.

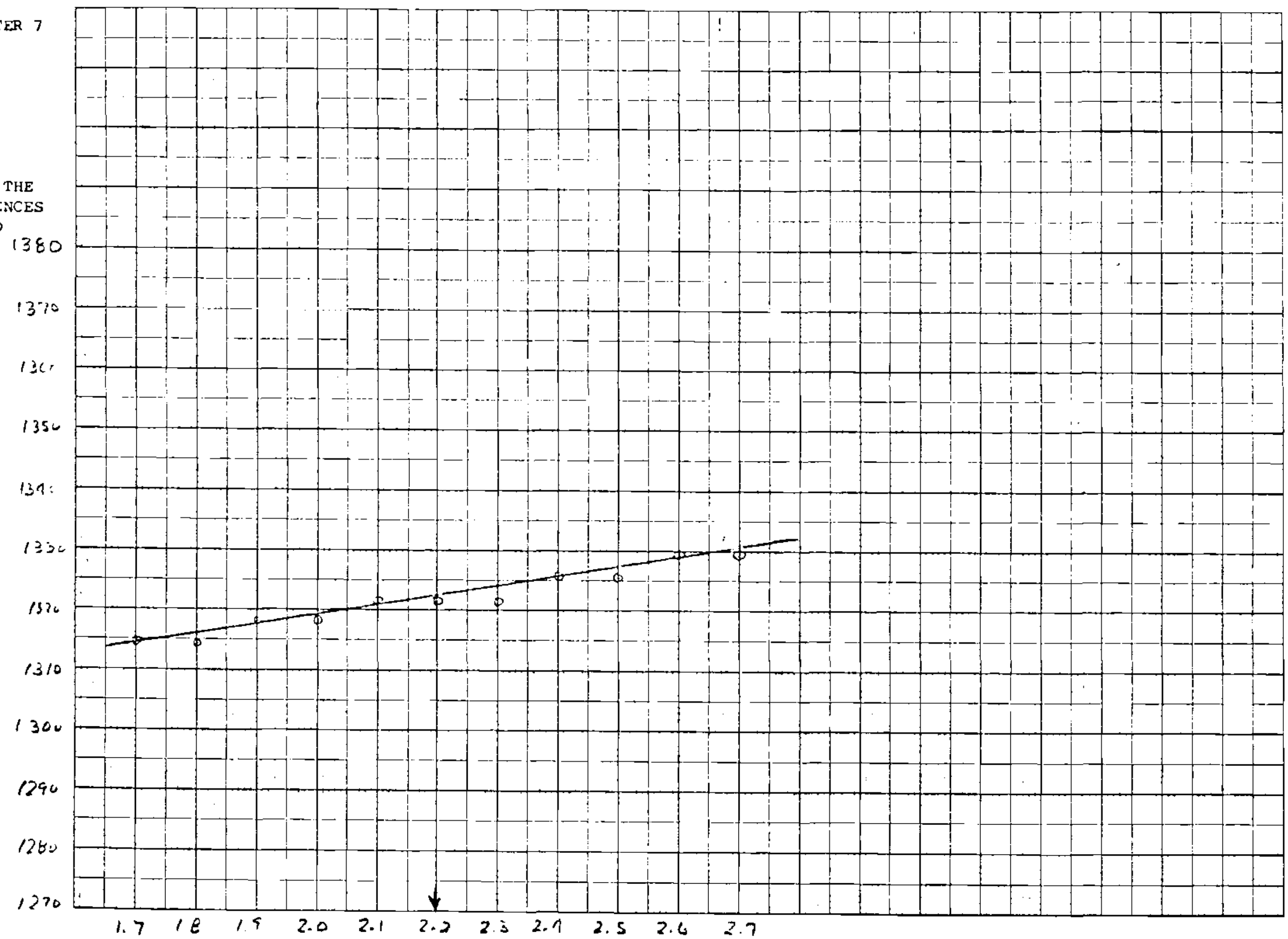

TYPE 4
PARAMETER 4
SUM OF THE DIFFERENCES SQUARED
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
7.5
7.6
7.7
7.8
7.9
8.0
8.1
8.2
8.3
8.4
8.5
AVG. PARAMETER 4 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.


TYPE 4
PARAMETER 5
SUM OF THE
DIFFERENCES
SQUARED
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
5.6
5.7
5.8
5.9
6.0
6.1
6.2
6.3
6.4
6.5
6.6
AVG. PARAMETER 5 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.
NO 334-2N. 10 X 10 TO THE HALF INCH

TYPE 4
PARAMETER 6

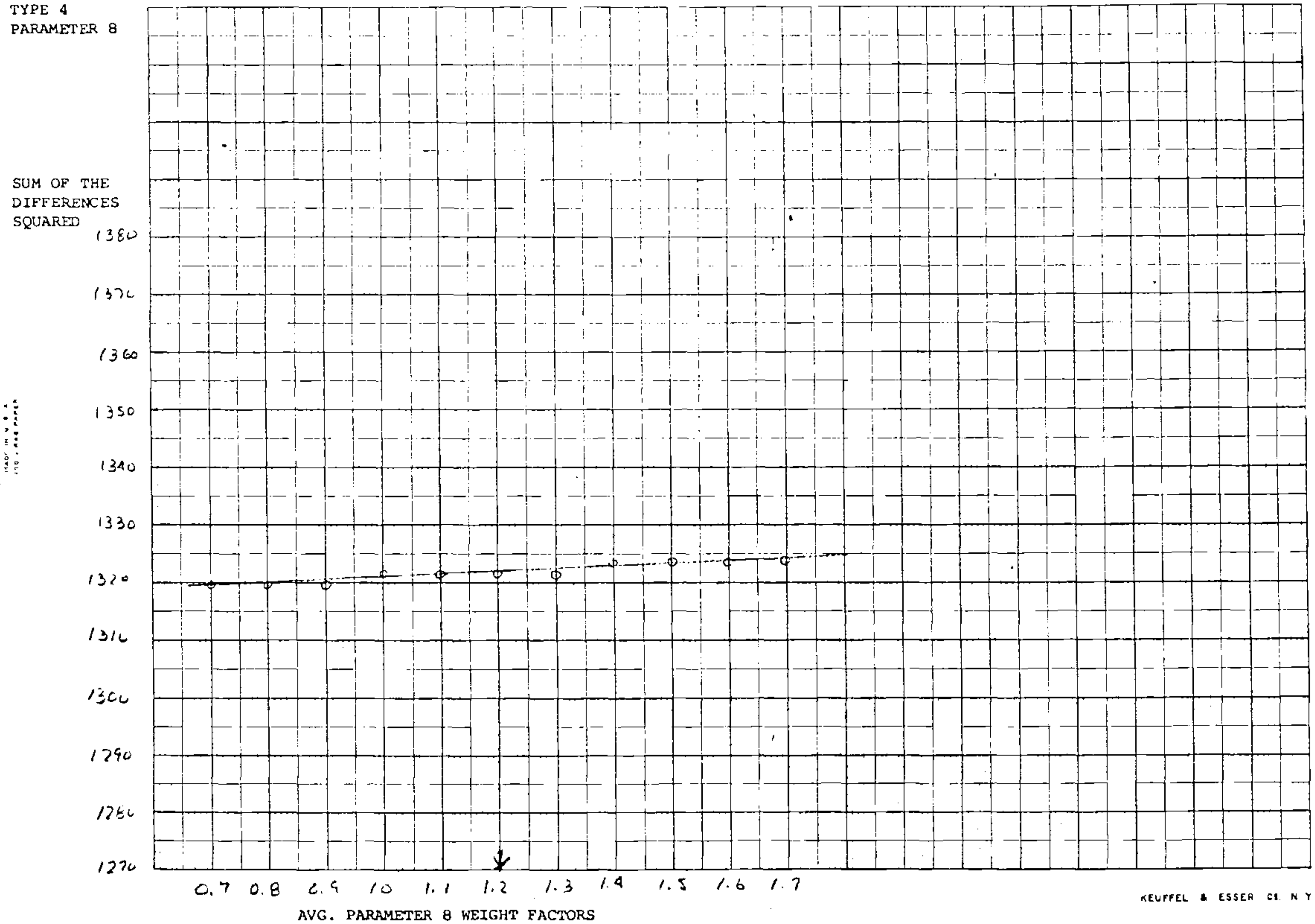
TYPE 4
PARAMETER 7

SUM OF THE
DIFFERENCES
SQUARED



AVG. PARAMETER 7 WEIGHT FACTORS

TYPE 4
PARAMETER 8



TYPE 4
PARAMETER 9

SUM OF THE
DIFFERENCES
SQUARED

AVG. PARAMETER 9 WEIGHT FACTORS

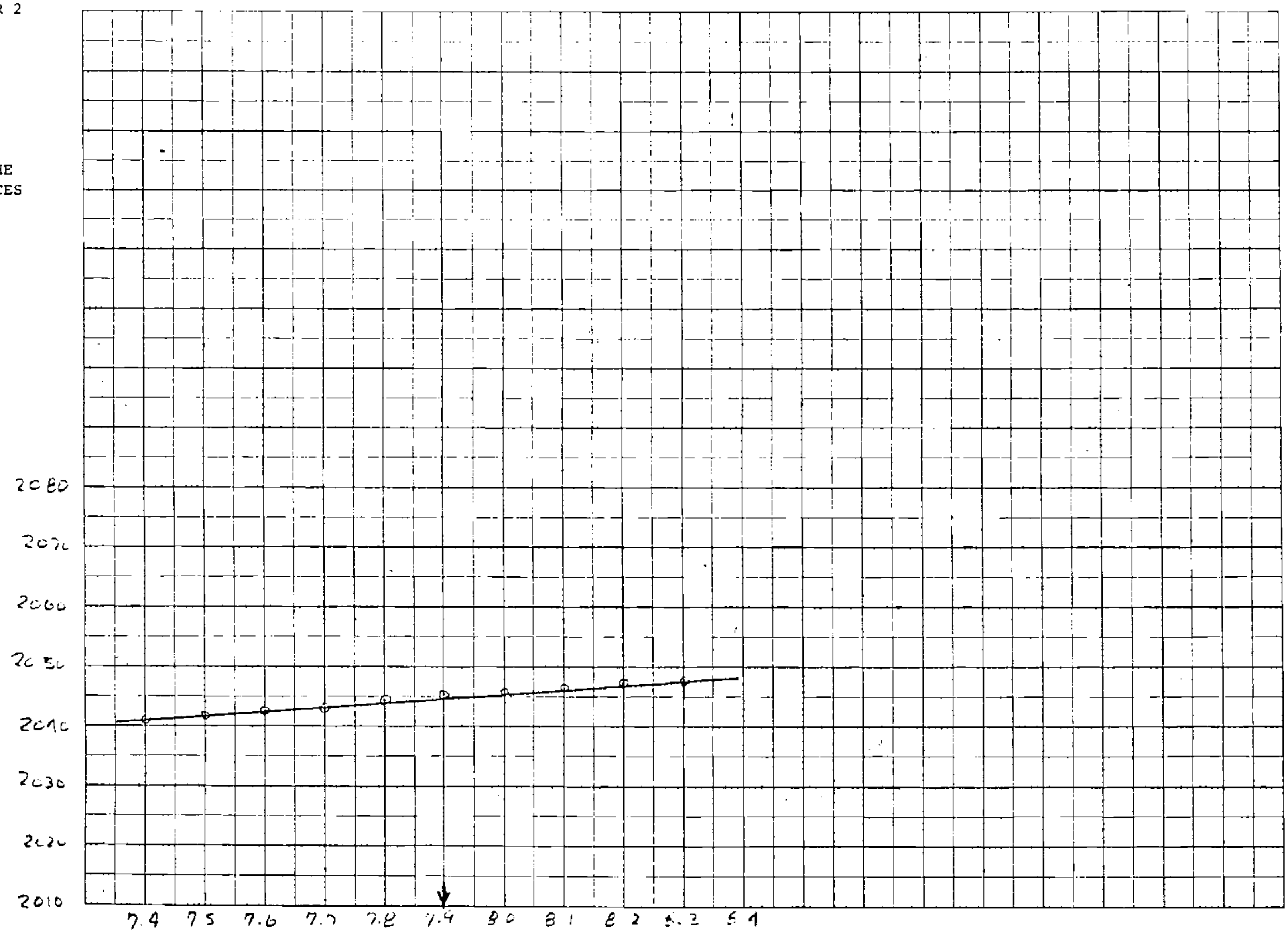
TYPE 5
PARAMETER 1

SUM OF THE
DIFFERENCES
SQUARED

AVG. PARAMETER 1 WEIGHT FACTORS

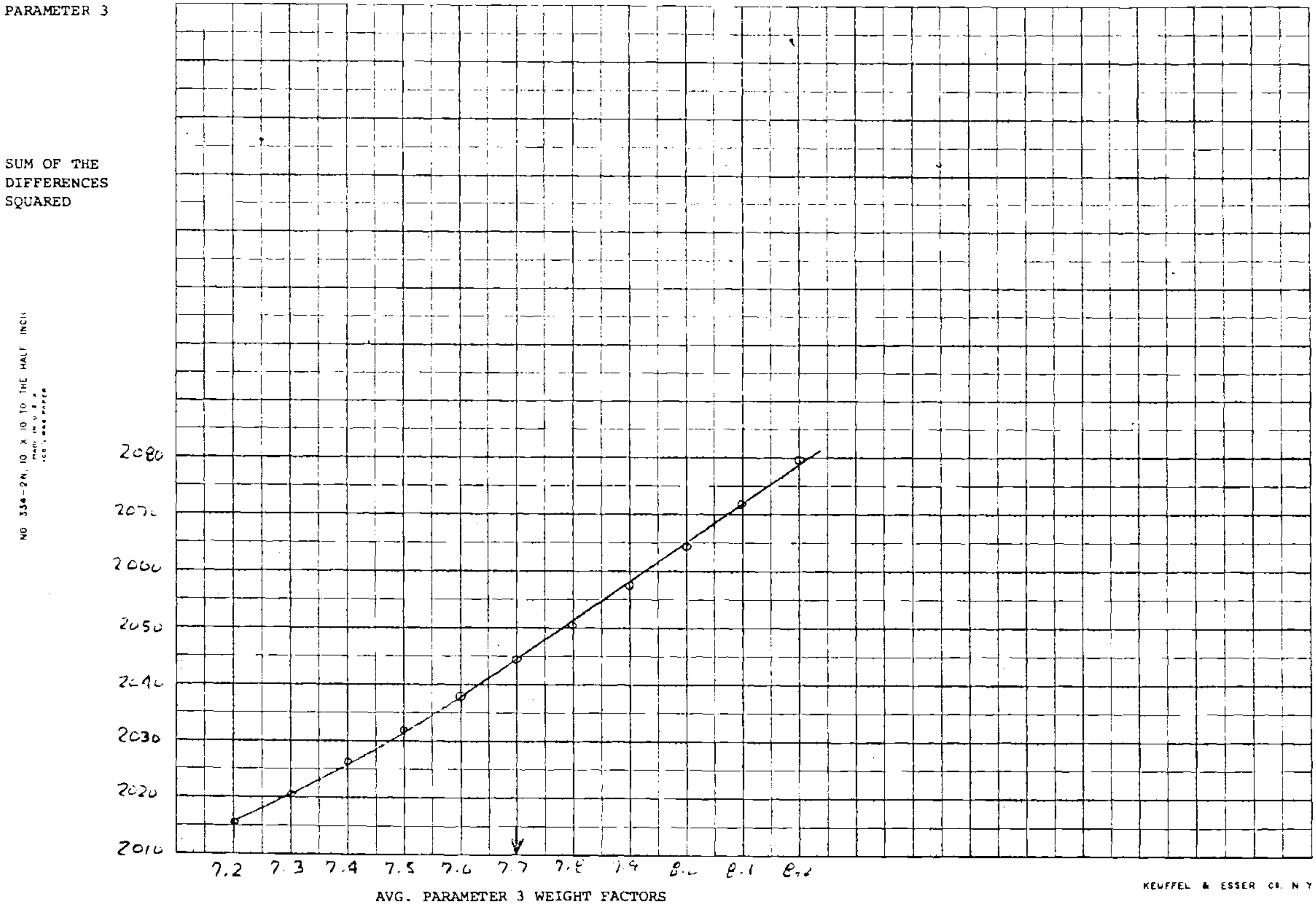
TYPE 5
PARAMETER 2

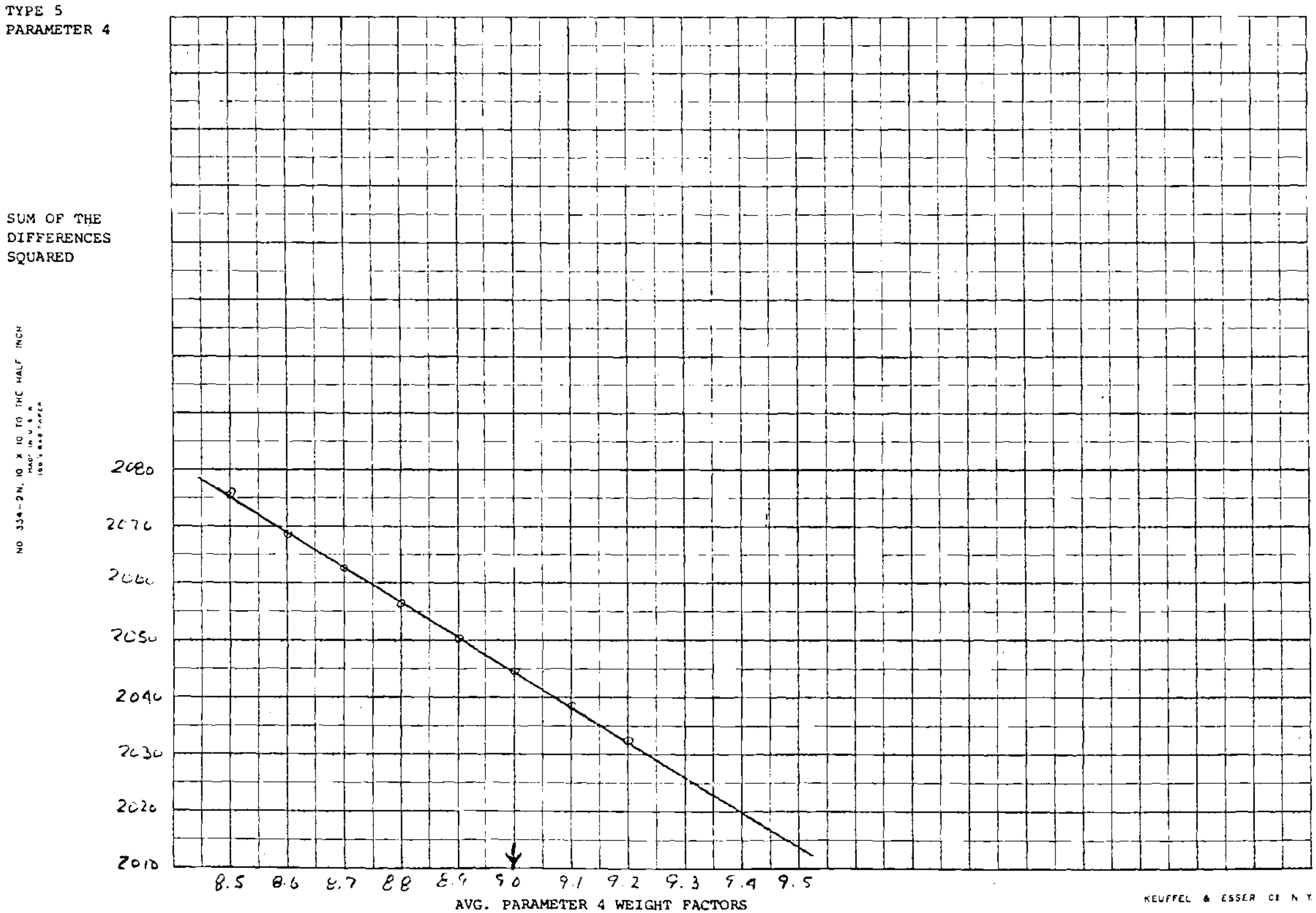
SUM OF THE
DIFFERENCES
SQUARED



AVG. PARAMETER 2 WEIGHT FACTORS

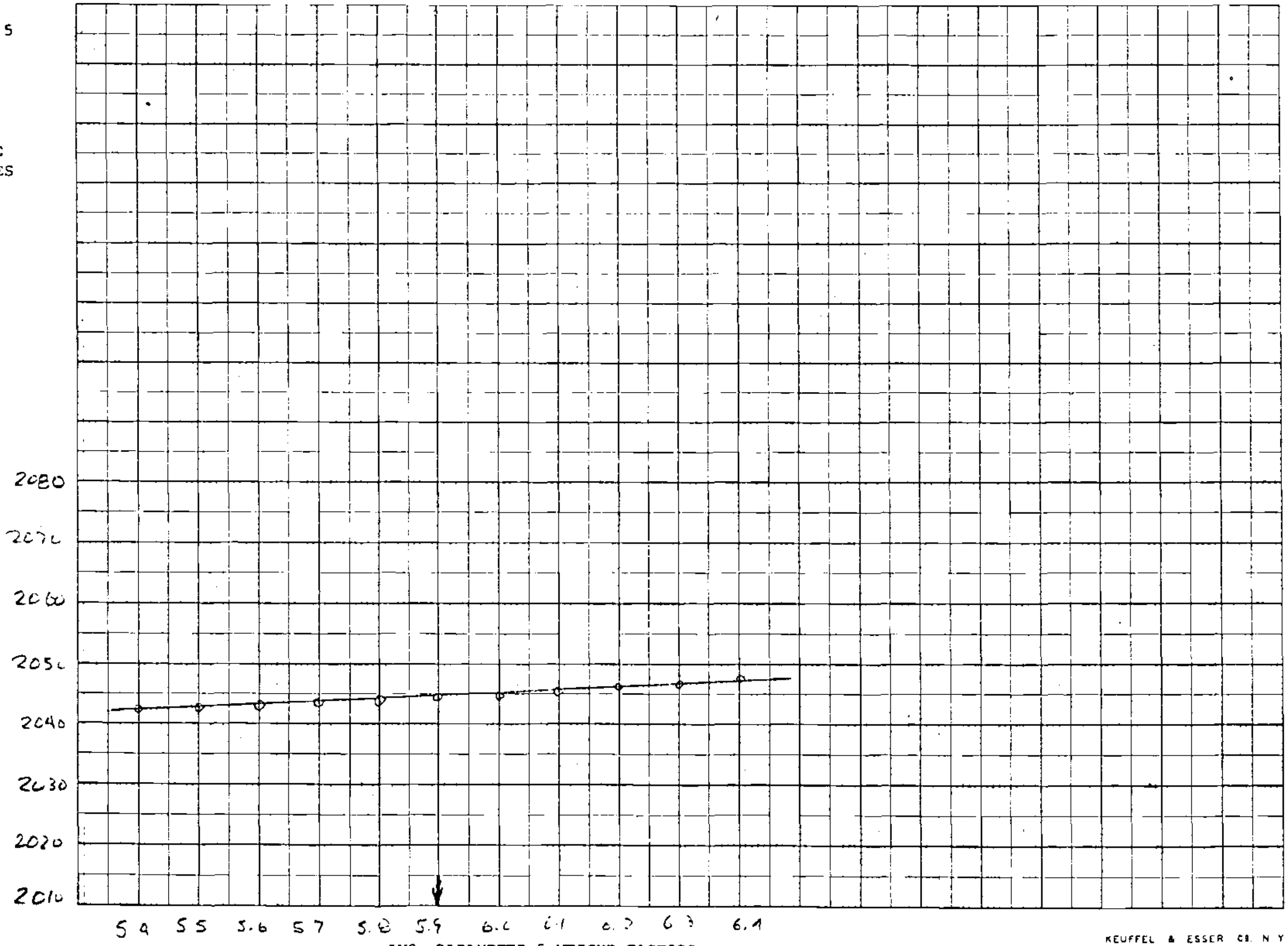
TYPE 5
PARAMETER 3




TYPE 5
PARAMETER 4
SUM OF THE DIFFERENCES SQUARED
2080
2070
2060
2050
2040
2030
2020
2010
8.5 8.6 8.7 8.8 8.9 9.0 9.1 9.2 9.3 9.4 9.5
AVG. PARAMETER 4 WEIGHT FACTORS
KEUFFEL & ESSER CO. N.Y.

TYPE 5
PARAMETER 5

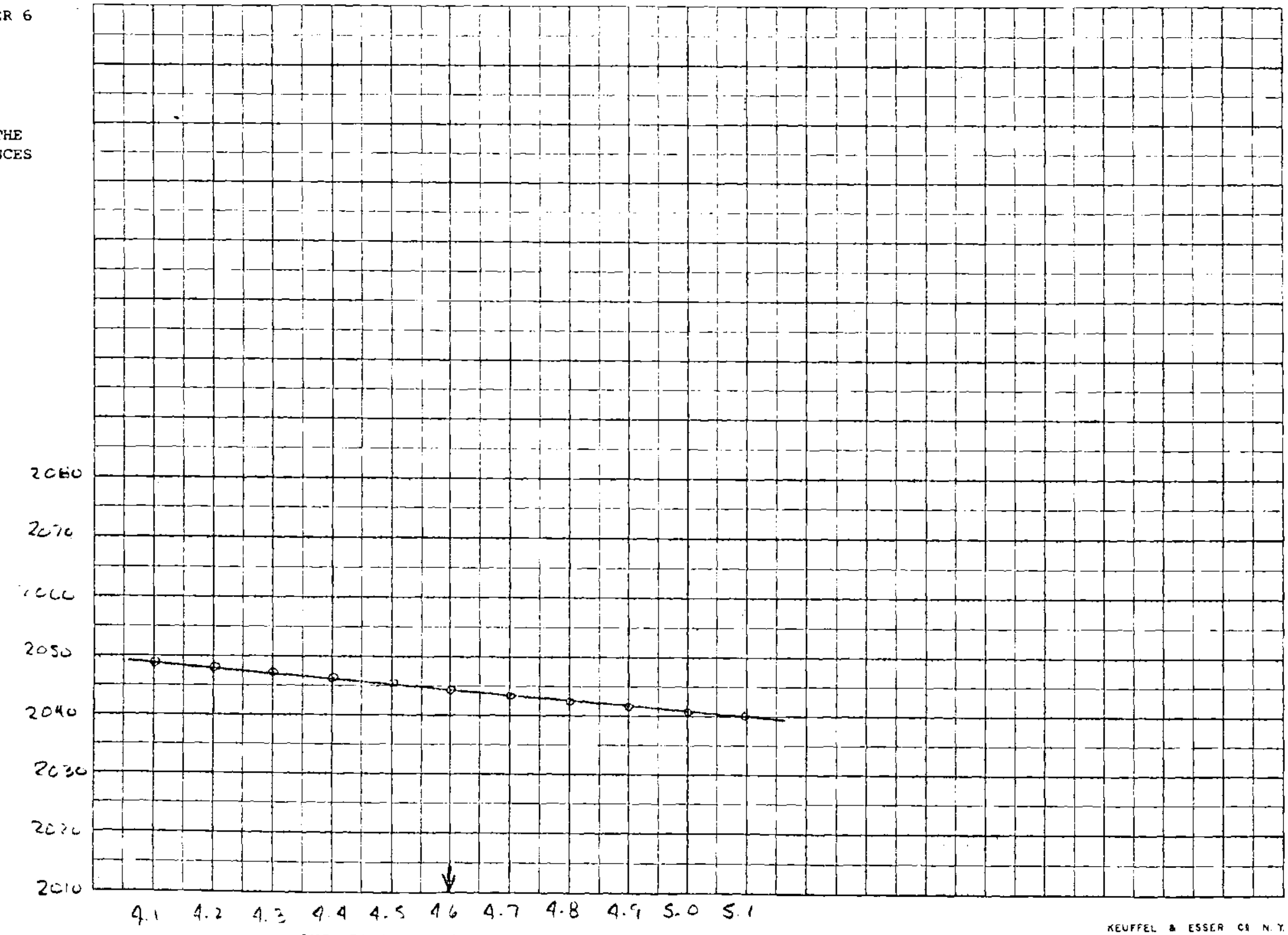
SUM OF THE
DIFFERENCES
SQUARED



AVG. PARAMETER 5 WEIGHT FACTORS

TYPE 5
PARAMETER 6

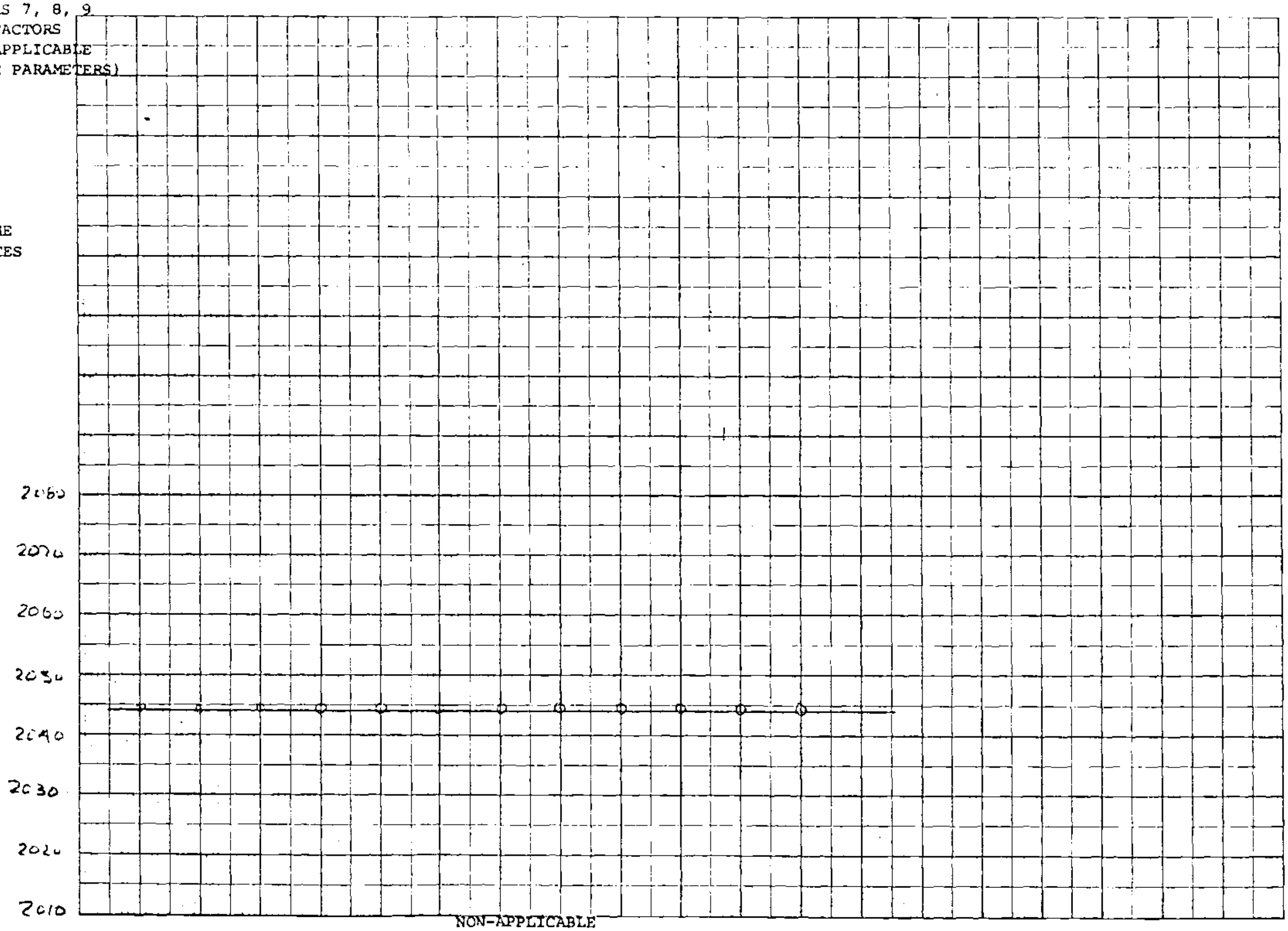
SUM OF THE
DIFFERENCES
SQUARED



AVG. PARAMETER 6 WEIGHT FACTORS

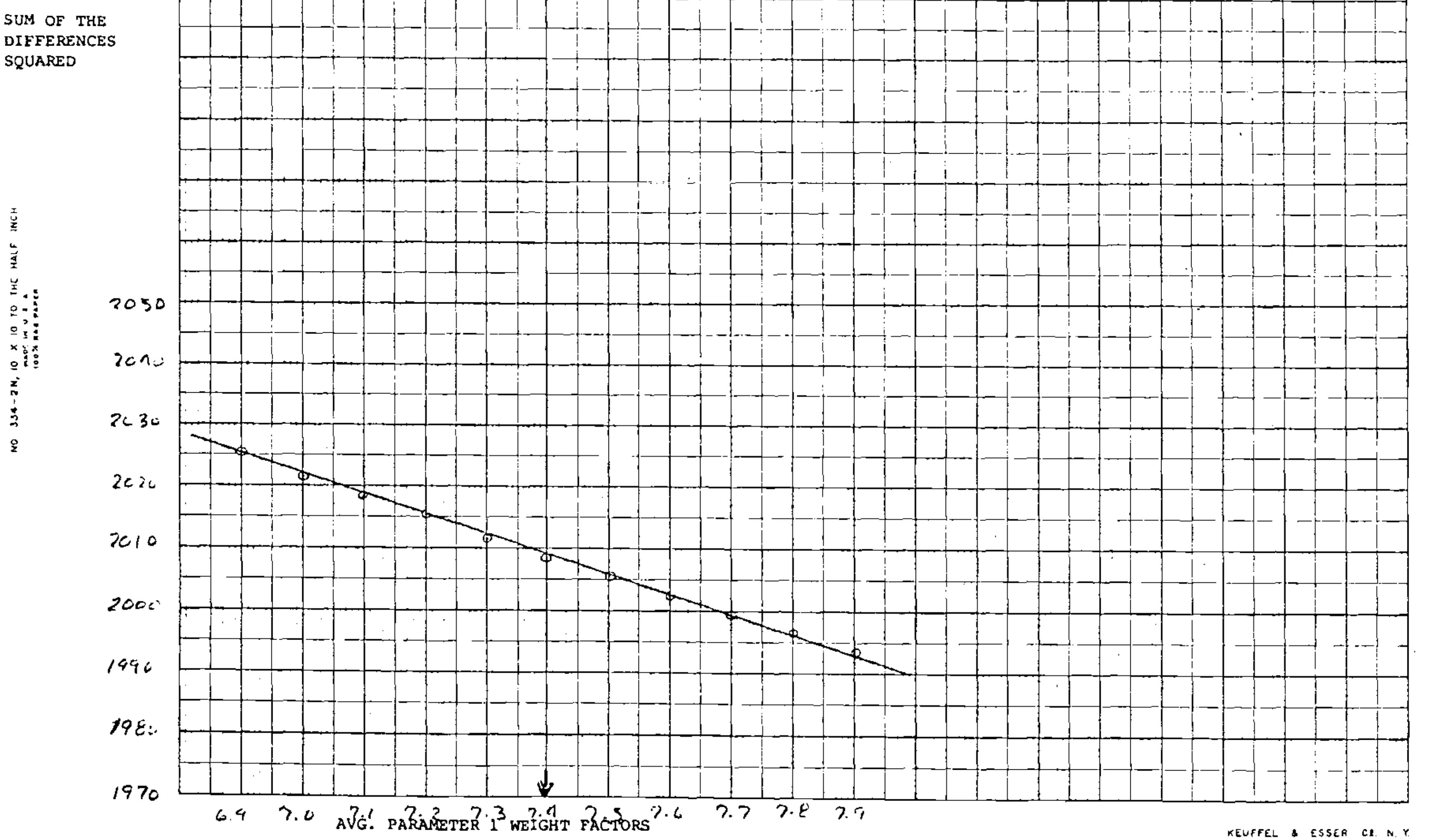
TYPE 5
PARAMETERS 7, 8, 9
(WEIGHT FACTORS
ARE NOT APPLICABLE
FOR THESE PARAMETERS)

SUM OF THE
DIFFERENCES
SQUARED

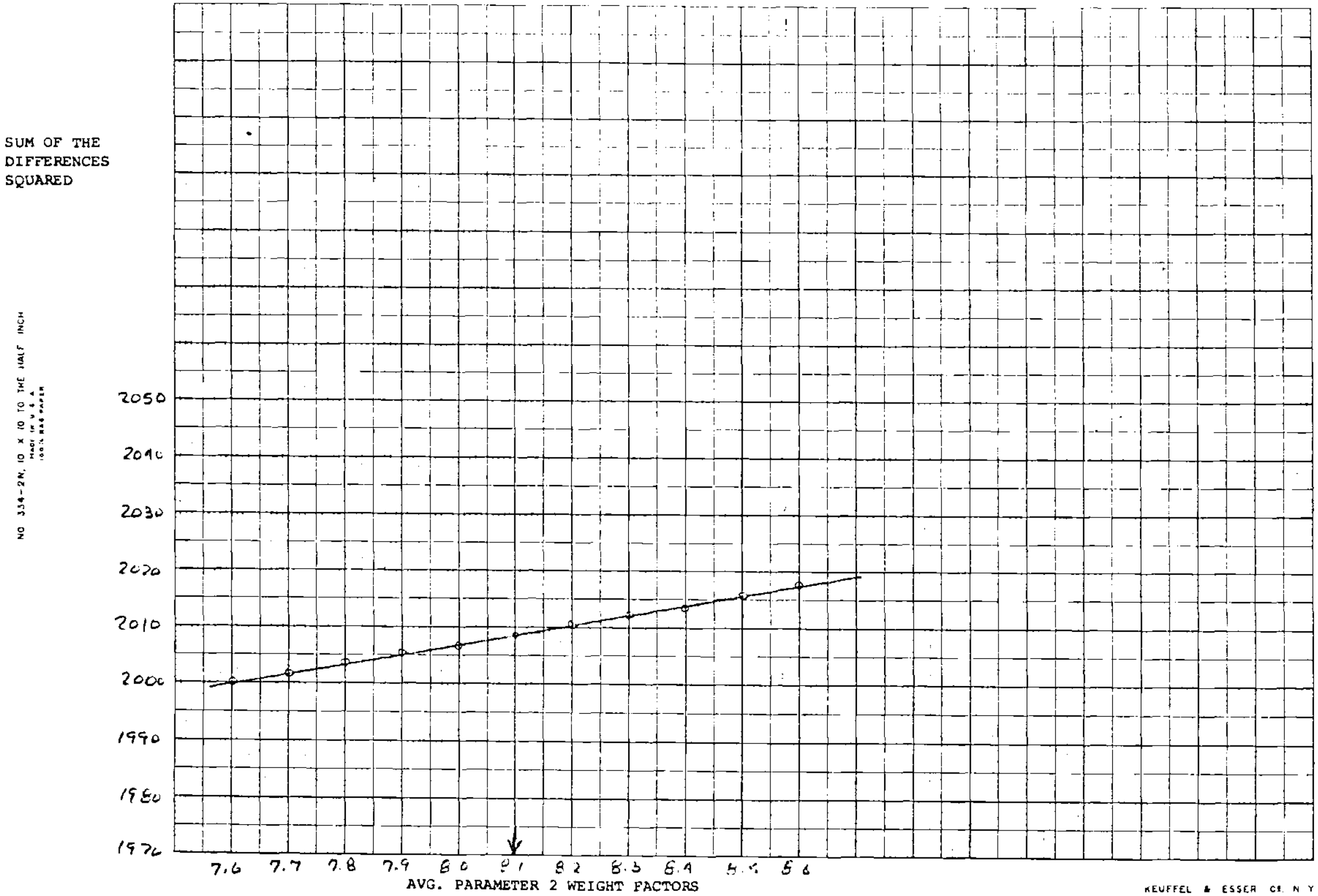


AVG. PARAMETERS 7, 8, 9 WEIGHT FACTORS,

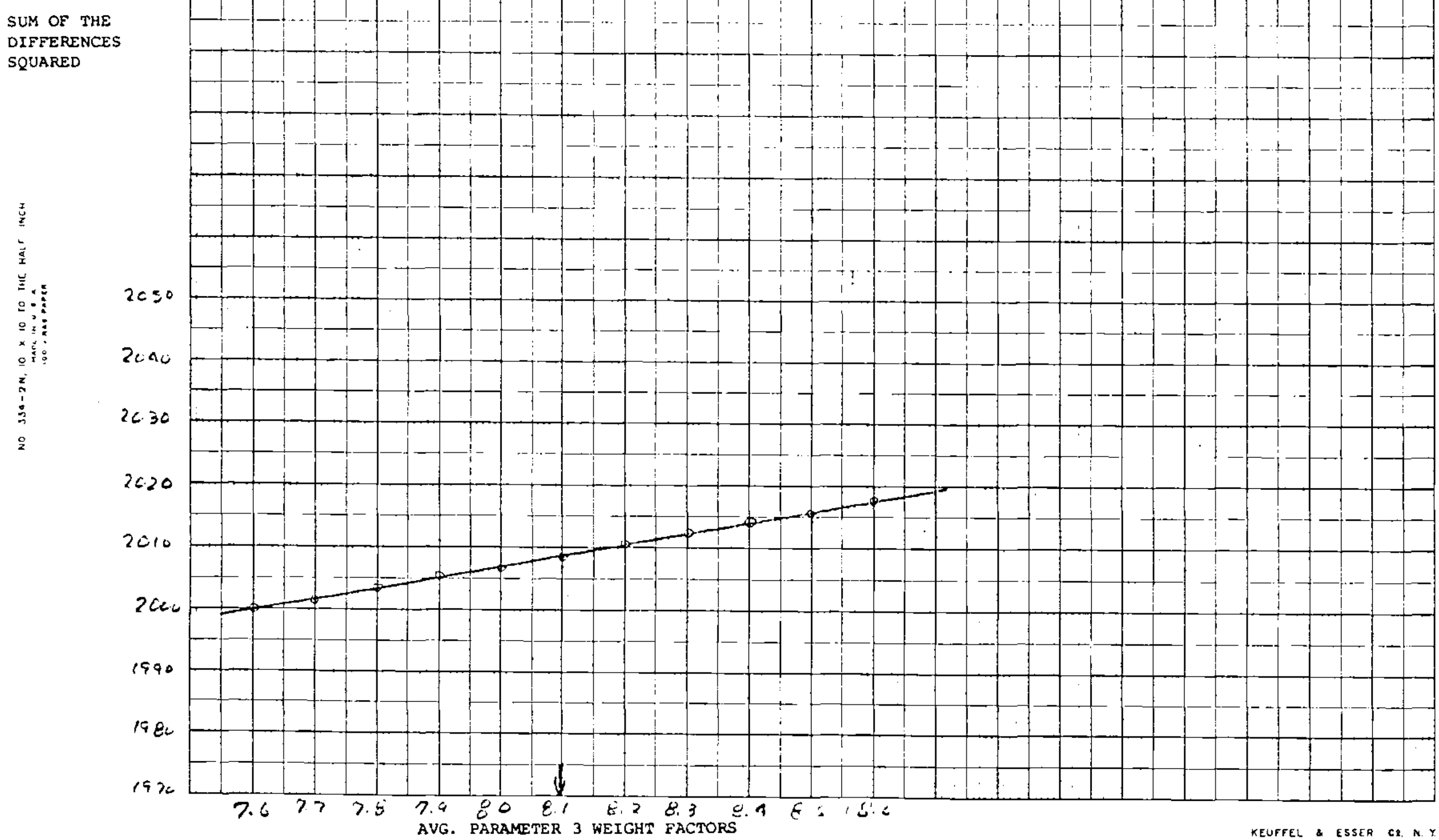
TYPE 6
PARAMETER 1



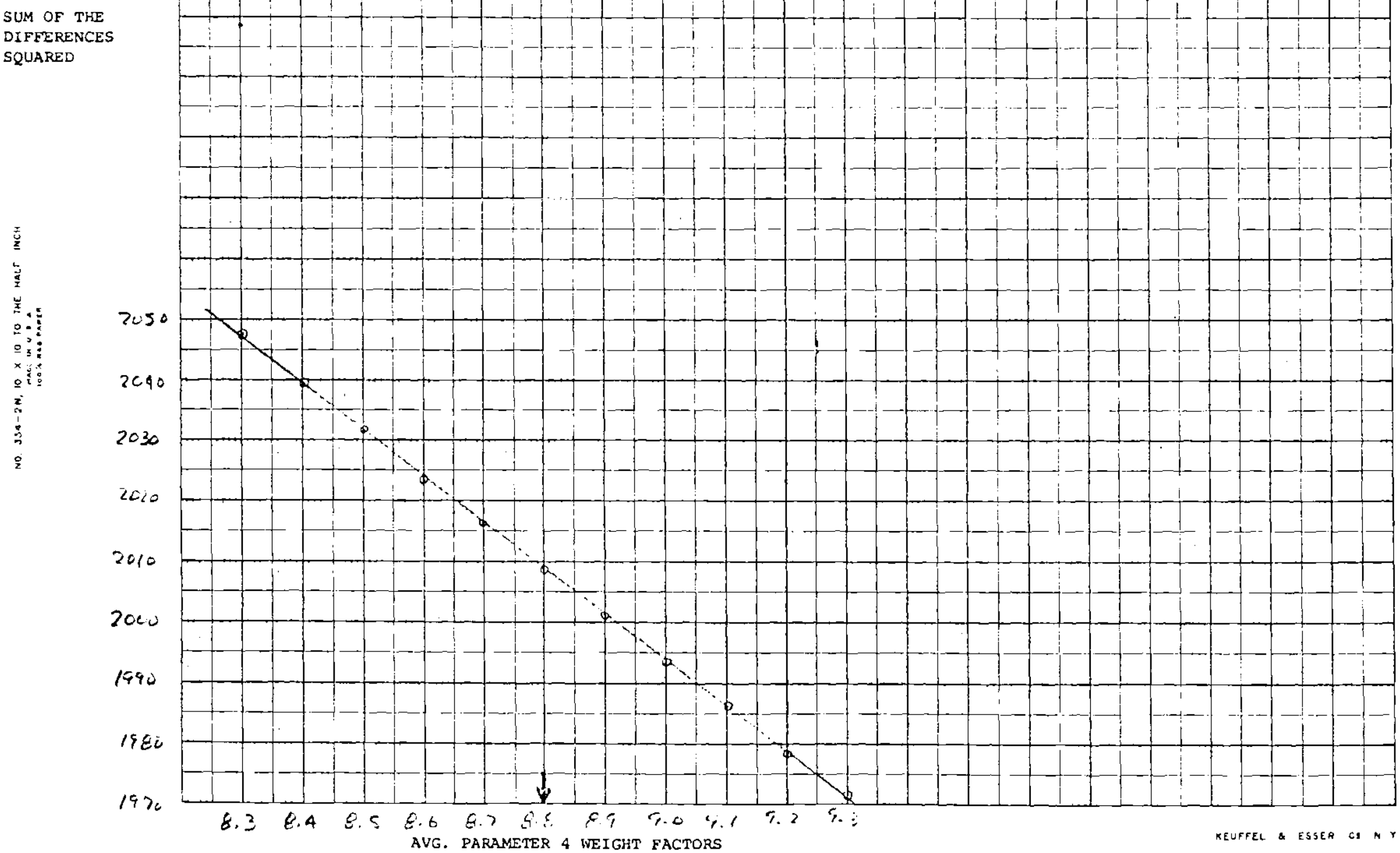
TYPE 6
PARAMETER 2



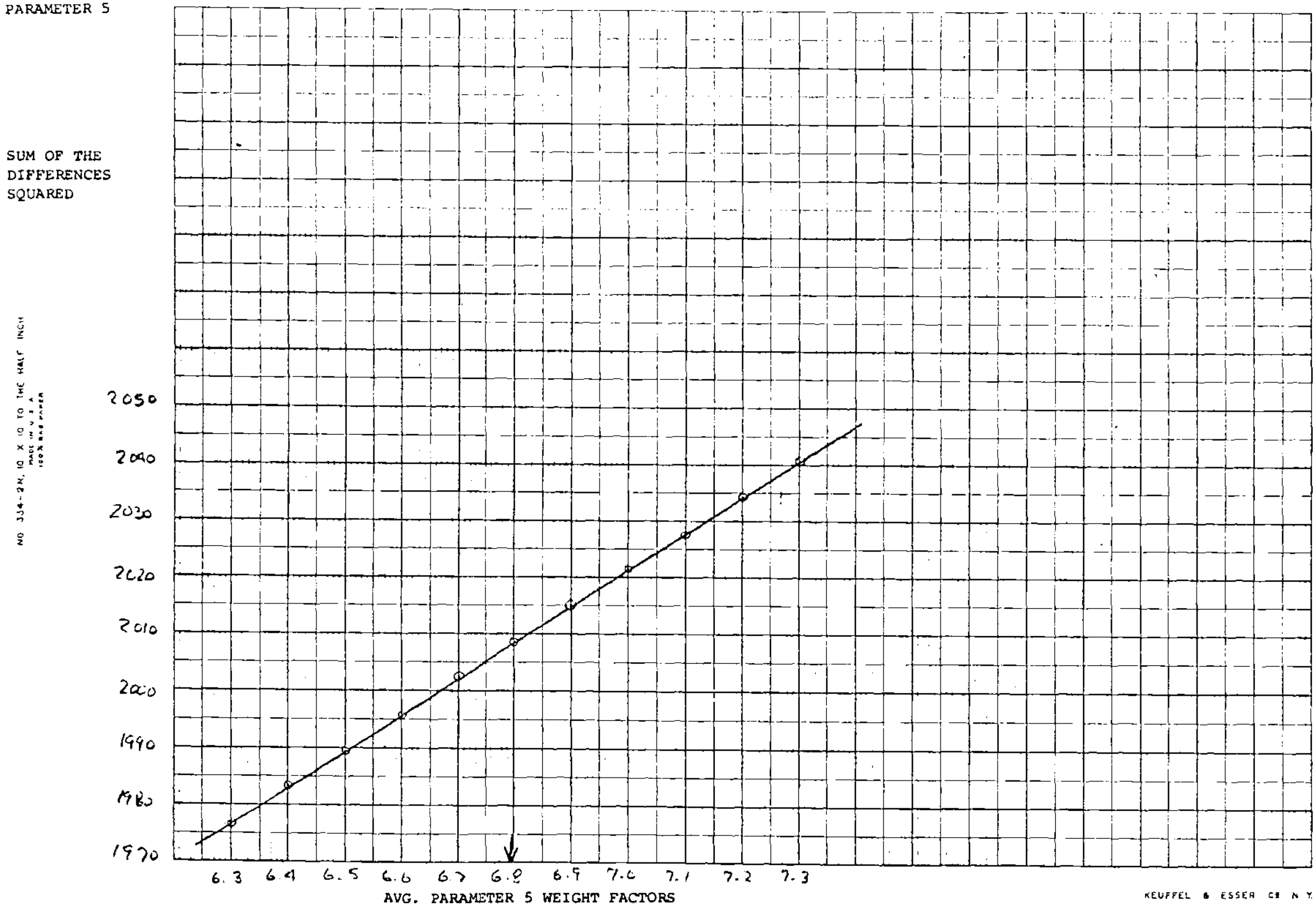
TYPE 6
PARAMETER 3



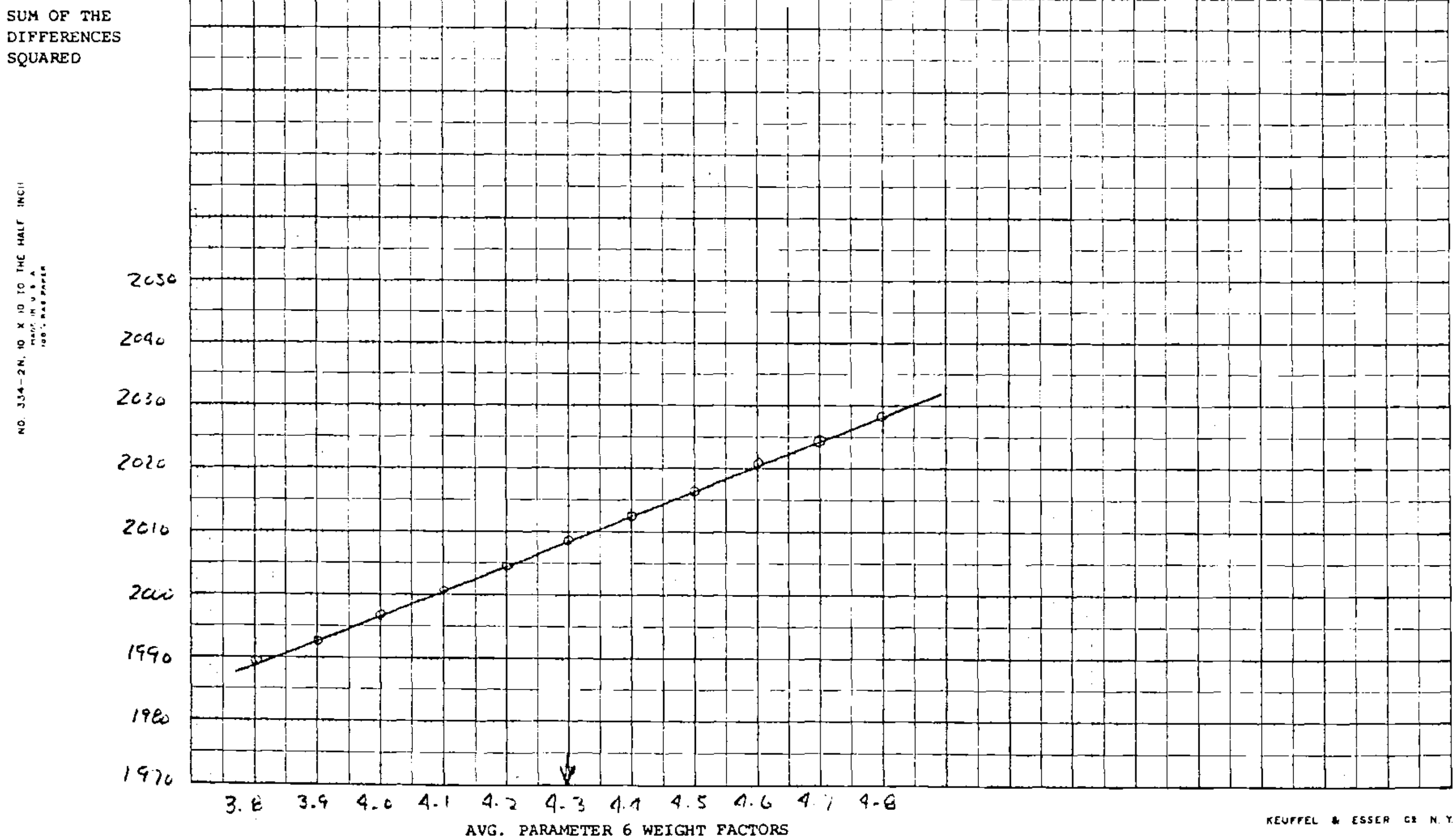
TYPE 6
PARAMETER 4



TYPE 6
PARAMETER 5

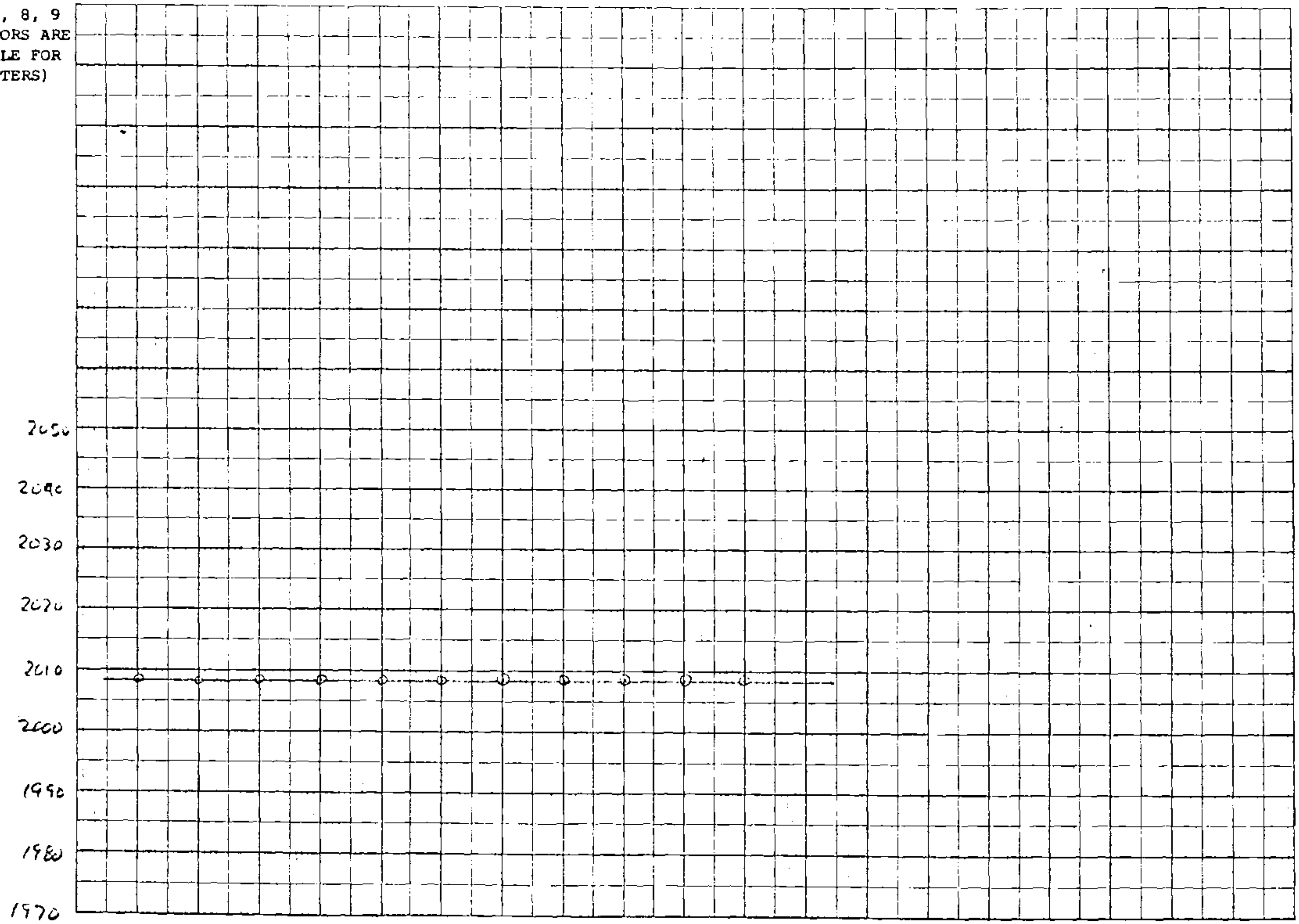


TYPE 6
PARAMETER 6



TYPE 6
PARAMETERS 7, 8, 9
(WEIGHT FACTORS ARE
NOT APPLICABLE FOR
THESE PARAMETERS)

SUM OF THE
DIFFERENCES
SQUARED



NON-APPLICABLE
AVG. PARAMETERS 7, 8, 9 WEIGHT FACTORS

APPENDIX E

Weighting Factors for Evaluation Factors

(Original and Adjusted)

ORIGINAL WEIGHT FACTORS

I. Need Parameter

	Type of Improvement	1	2	3	4	5	6
Factors	Transportation plans	8.8	8.4	6.1	5.4	6.5	7.2
	State, regional or local officials	7.2	7.2	7.0	7.1	7.5	7.2
	Department officials	8.1	7.8	8.6	9.0	8.2	8.6
	Community response	6.3	5.9	5.1	4.5	6.4	6.6
	Average (Parameter Weight)*	7.6	7.3	6.7	6.5	7.2	7.4

II. Physical Deficiency Parameter

	Type of Improvement	1	2	3	4	5	6
Factors	Structure Condition**	7.1	7.5	8.7	8.7	7.9	8.1
	Structure Adequacy**	7.1	7.5	8.7	8.7	7.9	8.1
	Pavement Condition**	7.1	7.5	8.7	8.7	7.9	8.1
	Pavement Adequacy**	7.1	7.5	8.7	8.7	7.9	8.1
	Average (Parameter Weight)	7.1	7.5	8.7	8.7	7.9	8.1

III. Operational Deficiency Parameter

	Type of Improvement	1	2	3	4	5	6
Factors	Traffic volume	8.1	8.1	6.7	6.6	7.9	7.8
	Volume/capacity ratio	8.2	8.3	6.5	7.9	7.0	8.4
	Speed and delay**	7.7	8.1	6.3	7.3	7.7	8.1
	Alignment and geometrics	6.9	7.8	5.7	7.3	8.2	8.2
	Average (Parameter Weight)	7.7	8.1	6.3	7.3	7.7	8.1

ORIGINAL WEIGHT FACTORS

IV. Safety Deficiency Parameter

	Type of Improvement	1	2	3	4	5	6
Factors	Accident experience	7.5	8.3	7.9	8.7	9.7	9.3
	Accident potential**	7.2	8.0	6.8	8.0	9.0	8.8
	Alignments and geometrics	6.9	7.8	5.7	7.3	8.2	8.2
	Average (Parameter Weight)	7.2	8.0	6.8	8.0	9.0	8.8

V. Continuity Parameter

	Type of Improvement	1	2	3	4	5	6
Factors	Existing highway network	7.6	6.9	4.7	5.8	5.6	6.8
	Multi-modal facilities**	7.7	7.3	5.3	6.1	5.9	6.8
	Other improvement projects	7.9	7.7	6.0	6.4	6.1	6.8
	Average (Parameter Weight)	7.7	7.3	5.3	6.1	5.9	6.8

VI. Benefit - Cost Parameter

	Type of Improvement	1	2	3	4	5	6
Factor	Benefit-Cost ratio	6.5	6.2	4.4	4.2	4.6	4.3
	Average (Parameter Weight)	6.5	6.2	4.4	4.2	4.6	4.3

VII. Economic Parameter

	Type of Improvement	1	2	3	4	5	6
Factors	Comprehensive plans	8.9	7.6	4.9	6.2	NA	NA
	Land value and development	6.1	5.7	4.2	NA	NA	NA
	Tax base**	6.0	5.3	4.4	4.8	NA	NA
	Employment	4.2	3.8	NA	NA	NA	NA
	Utilities	3.6	4.3	NA	NA	NA	NA
	Average (Parameter Weight)	5.8	5.3	2.7	2.2	-	-

ORIGINAL WEIGHT FACTORS

VIII. Social Parameter

	Type of Improvement	1	2	3	4	5	6
Factors	Displacement and relocations	6.6	4.3	NA	NA	NA	NA
	Social patterns	7.5	6.2	NA	NA	NA	NA
	Disruption during construction	5.0	5.1	4.9	4.8	NA	NA
	Preservation of historic, etc. sites	6.8	6.8	NA	NA	NA	NA
	Average (Parameter Weight)	6.5	5.6	1.2	1.2	-	-

IX. Environmental Parameter

	Type of Improvement	1	2	3	4	5	6
Factors	Aesthetics	6.8	6.0	4.7	6.2	NA	NA
	Air pollution	6.8	6.5	NA	NA	NA	NA
	Water pollution	7.8	6.6	6.5	7.0	NA	NA
	Noise pollution	6.8	6.5	NA	NA	NA	NA
	Physical resources**	7.7	6.7	5.0	5.8	NA	NA
	Biological resources**	7.7	6.7	5.0	5.8	NA	NA
	Average (Parameter Weight)	7.3	6.5	3.5	4.1	-	-

Types of Improvement:

1. New highway construction
2. Reconstruction and major highway upgrading
3. Minor highway upgrading
4. Structures, new and replacements
5. Safety improvements
6. Traffic engineering improvements

* The average factor weight is assumed as initial parameter weight, subject to future refinements.

** This factor is newly included and has no previously determined factor weight. It is therefore assumed that the factor weight will be the average factor weight of the component factor subject to future modifications.

ADJUSTED WEIGHT FACTORS

I. NEED PARAMETER

TYPE OF IMPROVEMENT	1	2	3	4	5	6
Transportation Plans	8.8	8.4	4.1	3.4	1.5	2.2
State, Regional, or Local Officials	7.2	7.2	5.0	5.1	2.5	2.2
Department Officials	8.1	7.8	6.6	7.0	5.2	3.6
Community Response	6.3	5.9	3.1	2.5	3.4	5.6
AVERAGE (PARAMETER WEIGHT)	7.6	7.3	4.7	4.5	3.2	3.4

II. PHYSICAL DEFICIENCY PARAMETER

TYPE OF IMPROVEMENT	1	2	3	4	5	6
Structural Condition	7.1	7.5	8.7	8.7	2.9	1.1
Structural Adequacy	7.1	7.5	8.7	8.7	2.9	1.1
Pavement Condition	7.1	7.5	8.7	8.7	2.9	1.1
Pavement Adequacy	7.1	7.5	8.7	8.7	2.9	1.1
AVERAGE (PARAMETER WEIGHT)	7.1	7.5	8.7	8.7	2.9	1.1

III. OPERATIONAL DEFICIENCY PARAMETER

TYPE OF IMPROVEMENT	1	2	3	4	5	6
Traffic Volume	8.1	8.1	9.2	5.6	6.9	5.8
Volume/Capacity Ratio	8.2	8.3	9.0	6.9	2.0	4.4
Speed and Delay	7.7	8.1	8.8	6.3	2.7	6.1
Alignment and Geometrics	6.9	7.8	8.2	6.3	3.2	4.2
AVERAGE (PARAMETER WEIGHT)	7.7	8.1	8.8	6.3	3.7	5.1

TYPE OF IMPROVEMENT:

1) New Construction
2) Reconstruction and Major Highway Upgrading
3) Minor Highway Upgrading
4) Structures, New & Replacements
5) Safety Improvements
6) Traffic Engineering Improvements

ADJUSTED WEIGHT FACTORS

IV. SAFETY DEFICIENCY PARAMETER

	TYPE OF IMPROVEMENT	1	2	3	4	5	6
FACTORS	Accident Experience	7.5	8.3	9.8	9.8	9.8	9.8
	Accident Potential	7.2	8.0	8.7	9.1	9.8	9.8
	Alignment and Geometrics	6.9	7.8	7.6	8.4	4.3	9.2
	AVERAGE (PARAMETER WEIGHT)	7.2	8.0	8.7	9.1	8.0	9.6

V. CONTINUITY PARAMETER

	TYPE OF IMPROVEMENT	1	2	3	4	5	6
FACTORS	Existing Highway Network	7.6	6.9	1.7	2.8	0.6	1.8
	Multi-Modal Facilities	7.7	7.3	2.3	3.1	0.9	0.8
	Other Improvement Proj.	7.9	7.7	3.0	3.4	1.1	1.8
	AVERAGE (PARAMETER WEIGHT)	7.7	7.3	2.3	3.1	0.9	1.5

VI. BENEFIT-COST PARAMETER

	TYPE OF IMPROVEMENT	1	2	3	4	5	6
FACTORS	Benefit-Cost Ratio	6.5	6.2	4.4	4.2	2.6	1.3
	AVERAGE (PARAMETER WEIGHT)	6.5	6.2	4.4	4.2	2.6	1.3

ADJUSTED WEIGHT FACTORS

VII. ECONOMIC PARAMETER

	TYPE OF IMPROVEMENT	1	2	3	4	5	6
FACTORS	Comprehensive Plans	8.9	7.6	4.4	4.2	NA	NA
	Land Value and Development	6.1	5.7	3.7	NA	NA	NA
	Tax Base	6.0	5.3	3.9	2.8	NA	NA
	Employment	4.2	3.8	NA	NA	NA	NA
	Utilities	3.6	4.3	NA	NA	NA	NA
AVERAGE (PARAMETER WEIGHT)		5.8	5.3	2.4	1.4	-	-

VIII. SOCIAL PARAMETER

	TYPE OF IMPROVEMENT	1	2	3	4	5	6
FACTORS	Displacement & Relocations	6.6	4.3	NA	NA	NA	NA
	Social Patterns	7.5	6.2	NA	NA	NA	NA
	Disruption during Constr.	5.0	5.1	3.2	3.6	NA	NA
	Preservation of Historic Sites, etc.	6.8	6.8	NA	NA	NA	NA
AVERAGE (PARAMETER WEIGHT)		6.5	5.6	0.8	0.9	-	-

IX. ENVIRONMENTAL PARAMETER

	TYPE OF IMPROVEMENT	1	2	3	4	5	6
FACTORS	Aesthetics	6.8	6.0	2.7	6.2	NA	NA
	Air Pollution	6.8	6.5	NA	NA	NA	NA
	Water Pollution	7.8	6.6	4.5	7.0	NA	NA
	Noise Pollution	6.8	6.5	NA	NA	NA	NA
	Physical Resources	7.7	6.7	3.0	5.8	NA	NA
	Biological Resources	7.7	6.7	3.0	5.8	NA	NA
AVERAGE (PARAMETER WEIGHT)		7.3	6.5	2.2	4.1	-	-

APPENDIX F

Computer Program Developed for Implementation of Model

```
00270      51 NI=2.718281828**ICP*G(NIMP)                                   000320
00271         S=(SCORE(1,J,NIMP)/SCORE(2,J,NIMP))*10                         000325
00272         X=S*NI                                                         000331
00273         IF(SCORE(5,J,NIMP).EQ.999.)GO TO 54                            000333
00275         DELTA=(SCORE(5,J,NIMP)-X)**2                                   000336
00276         SUM=SUM+DELTA                                                  000341
00277         GO TO 54                                                       000343
00300      52 ICP=0                                                          000345
00301         GO TO 51                                                       000345
00302      54 WRITE(6,500)SCORE(5,J,NIMP),NI,S,X,DELTA,SUM                   000347
00312     500 FORMAT(1H ,3F10.2,3F15.4)                                      000366
00313      53 CONTINUE                                                       000366
00314      75 WRITE(6,71)                                                    000366
00320      71 FORMAT(1H0,'END OF JOB')                                       000373
00321         CALL EXIT                                                      000373
00322      90 WRITE(6,91)LIMP,LP                                             000376
00326      91 FORMAT(1H1,'NO DATA RECORDED FOR IMPROVEMENT TYPE',I2,          000404
00325        1' AND PROJECT #'I7)                                            000404
00327         CALL EXIT                                                      000404
00330         END                                                            000410
END FOR:   1 DIAGS
```

```
00137          DO 2 L=1,6                                                        000042
00142        2 SCORE(L,J,1)=' '                                                  000042
00145          LP=0                                                              000044
00147          LIMP=0                                                            000045
00150          WRITE(6,308)WFAC,WPAR                                             000046
00154      308 FORMAT(1H ,12F5.1)                                                000061
00155          WRITE(6,4)                                                        000061
00157        4 FORMAT(1H0,'FORMAT OF RATINGS BEING READ: '/' TYPE OF IMPROVEMENT 000067
00157         1(COL 1)'/' PROJECT NO.(COL 2-3)'/' PARAMETER ID.(COL 4)'/' RATINGS 000067
00157         ,2(COL 5-28;SIX DIGIT FIELDS)')                                    000067
00160        5 READ(4,6,END=9)IMP,IP,K,RAT                                       000067
00165        6 FORMAT(I1,I2,I1,6F4.0)                                            000102
00167          IF(LIMP.NE.IMP)GO TO 20                                           000102
00171          IF(IP.NE.LP)GO TO 205                                             000105
00171   C SUM WFAC-RATING PRODUCTS (SIX WFACS/PARAMETER MAXIMUM)                 000105
00173        7 DO 8 I=1,6                                                        000111
00176          IF(RAT(I).LQ.99.)GO TO 8                                          000121
00200          IF(WFAC(IMP,I,K).EQ.99.)GO TO 8                                   000123
00202          S1(K)=S1(K)+WFAC(IMP,I,K)*RAT(I)                                  000126
00203          T1(K)=T1(K)+WFAC(IMP,I,K)                                         000132
00204        8 CONTINUE                                                          000140
00206          IF(T1(K).EQ.0.)GO TO 5                                            000140
00210          RPAR(K)=S1(K)/T1(K)                                               000142
00211          GO TO 5                                                           000145
00212        9 IMP=7                                                             000147
00212   C STORE WEIGHTED PRODUCTS AND OTHER VARIABLES FOR PROJECT                000147
00213       20 IF(LIMP.EQ.0)GO TO 22                                             000151
00213   C  STORE NUMBER OF PROJECTS FOR THIS IMPROVEMENT                         000151
00215          NOP(LIMP)=LP                                                      000152
00215      205 DO 21 I=1,9                                                       000156
00221          IF(T1(I).EQ.0.OR.WPAR(IMP,I).EQ.99.)GO TO 21                      000174
00223          SCORE(1,LP,LIMP)=SCORE(1,LP,LIMP)+WPAR(LIMP,I)*RPAR(I)            000205
00224          SCORE(2,LP,LIMP)=SCORE(2,LP,LIMP)+WPAR(LIMP,I)                    000211
00225       21 CONTINUE                                                          000220
00225   C      WRITE(6,31)LP,LIMP                                                000220
00225   C   31 FORMAT(//'0ENTER TRAFFIC VOLUME(COL 1-5), COST(COL 6-13), AND     000220
00225   C     1DELPHI RATING(COL 14-17) FOR PROJECT'I3,' IMPROVEMENT'I2)         000220
00227          READ(5,32,END=99)TRAFIC,COST,DELPHI                               000220
00234       32 FORMAT()                                                          000231
00235          SCORE(3,LP,LIMP)=TRAFIC                                           000231
00236          SCORE(4,LP,LIMP)=COST                                             000233
00237          SCORE(5,LP,LIMP)=DELPHI                                           000235
00240       22 DO 23 I=1,9                                                       000240
00243          RPAR(I)=0.                                                        000245
00244          S1(I)=0.                                                          000245
00245       23 T1(I)=0.                                                          000246
00247          LP=IP                                                             000250
00250          LIMP=IMP                                                          000252
00251          IF(IMP.NE.9)GO TO 7                                               000254
00253      112 DO 53 NIMP=NIMP1,NIMP2                                            000262
00256          SUM=0.                                                            000266
00257          JL=NOP(NIMP)                                                      000267
00260          DO 53 J=1,JL                                                      000271
00263          IF(SCORE(2,J,NIMP).EQ.' ')GO TO 53                                000275
00265          IF(SCORE(3,J,NIMP).EQ.999.OR.SCORE(4,J,NIMP).EQ.999.)GO TO 52     000277
00267          TCP=(SCORE(3,J,NIMP)/SCORE(4,J,NIMP))*P(NIMP)                     000313
00267   C      ALOG=ALOG10(TCP)                                                  000313
```

```
@FOR,S RD.PRIMOD2
FOR SE2H-07/23/75-14:35:57 (9,)

MAIN PROGRAM

STORAGE USED: CODE(1) 002411; DATA(0) 010044; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

 0003  EXIT
 0004  NINTR$
 0005  NWDU$
 0006  NIO2$
 0007  NRDU$
 0010  NIO3$
 0011  XPRR
 0012  NSTOP$

STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

 0000   007776 1F       0001   000042 132G     0001   000042 135G     0001   000042 140G     0001   000121 174G
 0001   000151 20L      0001   000156 205L     0001   000215 21L      0001   000174 217G     0001   000240 22L
 0001   000243 241G     0001   000262 254G     0001   000275 261G     0000   007723 295F     0000   007734 299F
 0000   007743 305F     0000   010001 32F      0000   007742 4F       0001   000057 5L       0000   010002 500F
 0001   000320 51L      0001   000345 52L      0001   000362 53L      0001   000347 54L      0000   007776 6F
 0001   000311 7L       0000   010006 71F      0001   000136 8L       0001   000147 9L       0001   000376 90L
 0000   010012 91F      0000 R 007712 COST     0000 R 007713 DELPHI   0000 R 007722 DELTA    0000 I 007701 I
 0000 I 007706 IMP      0000 I 007707 IP       0000 I 007702 J        0000 I 007716 JL       0000 I 007710 K
 0000 I 007703 L        0000 I 007705 LIMP     0000 I 007700 LOOP     0000 I 007704 LP       0000 R 007675 NI
 0000 I 007714 NIMP     0000 I 007676 NIMP1    0000 I 007677 NIMP2    0000 I 007667 NOP      0000 R 007653 P
 0000 R 007661 Q        0000 R 000572 RAT      0000 R 007642 RPAR     0000 R 007720 S        0000 R 000600 SCORE
 0000 R 007715 SUM      0000 R 007620 S1       0000 R 007717 TCP      0000 R 007711 TRAFIC   0000 R 007631 T1
 0000 R 000000 WFAC     0000 R 000504 WPAR     0000 R 007721 X


00000  *DIAGNOSTIC*  THE NAME NUM APPEARS IN A DIMENSION OR TYPE STATEMENT BUT IS NEVER REFERENCED.
00100        C  DIMENSIONED FOR 6 IMPROVEMENTS AND 100 PROJECTS                              000000
00101              DIMENSION WFAC(6,6,9),WPAR(6,9),RAT(6),SCORE(5,100,6),S1(9),              000000
00101            1T1(9),RPAR(9)                                                              000000
00103              DIMENSION P(6),Q(6),NOP(6)                                                000001
00104              DATA P/2.62,.9,.67,10.6,0.,0.7/,Q/1.07,1.365,1.28,1.328,1.27,1.057/       000001
00107              REAL NUM                                                                  000001
00110              REAL NI                                                                   000001
00111              WRITE(6,298)                                                              000001
00113          298 FORMAT(1H ,'ENTER "TYPE OF IMPROVEMENT" RANGE (X,X)')                     000006
00114              READ(5,299)NIMP1,NIMP2                                                    000006
00120          299 FORMAT(I1,1X,I1)                                                          000015
00121              READ(2,1)WFAC                                                             000015
00124            1 FORMAT(9F2.1)                                                             000025
00125              READ(2,1)WPAR                                                             000025
00130              LOOP=1                                                                    000035
00131          335 DO 2 I=1,6                                                                000042
00134              DO 2 J=1,100                                                              000042
```

BIBLIOGRAPHY

1. Georgia's 20 Year 1974 Multi-Modal Transportation Plan, Department of Transportation, State of Georgia, 1974.

2. Hayden-Cartwright Act of 1934; Title 23, United States Code, "Highways," Chapter 3, Section 307, Research and Planning.

3. School of Civil Engineering Georgia Institute of Technology; Proceedings of the Nineteenth Annual Georgia Highway Conference, March 9-10, 1970.

4. Mak, King Kuen, Priority Analysis for Ranking of Transportation Projects, Department of Transportation, State of Georgia, Atlanta, Georgia, August 1973.

5. Dalkey, Norman Company, The Delphi Method: An Experimental Study of Group Opinion, United States Air Force Project Rand, Santa Monica, California, June 1969.

6. Brown, B., Cochran, S., and Dalkey, N., The Delphi Method, II: Structure of Experiments, The Rand Corporation, Santa Monica, California, June 1969.

7. Rescheo, Nicholas, Delphi and Values, The Rand Corporation, Santa Monica, California, September 1969.

8. 5-Year Construction Work Program, Georgia Department of Transportation.

9. Mundt, Barry M., Keiser, M. Gordon, Oslin, Curtis D., Development of a Multi-Project Programming and Scheduling System, Department of Transportation, State of Georgia, 1973.

10. Roy Jorgensen Associates, Inc., Development of a Transportation Planning Systems, Final Report, Gaithersburg, Maryland, May 1975.

11. Agent, K. R., Mayes, J. G., Pigman, J. G., and Zegeer, C. V., Optimal Highway Safety Improvement Investments by Dynamic Programming. Department of Transportation Bureau of Highways, Lexington, Kentucky, December 1974.

12. Anderson, Donald R., and Goetz, Gerald E., Engineering Resource Planning and Utilization in the State of Washington. Paper presented at the annual meeting of the Transportation Research Board, Washington, D. C., January 13-17, 1975.

BIBLIOGRAPHY (Concluded)

13. Batchelor, Thomas J., Chatterjee, Arun, and Sinha, Kumares C., A Benefit-Cost Analysis of a Freeway System With Respect to an Average Real Estate Property Taxpayer in the City of Milwaukee. Paper presented at the 54th annual meeting of the Transportation Research Board, Washington, D. C., January 13-17, 1975.

14. Corradino, Joseph C., Jarvis, John J., Schimpeler, Charles C., and Unger, V., (Ed.), Optimum Staging of Projects in a Highway Plan.

15. Larwin, Thomas F. and Stuart, Darwin G., An issue-Oriented Approach to Enviornmental Impact Analysis. Paper presented at the 54 annual meeting of the Transportation Research Board, Washington, D. C., January 13-17, 1975.

16. Mak, King K. and Breen, Florence L., Application of the Delphi Technique to Priority Analysis, Unpublished paper, February 1975.

17. Stearns, Palmer N. and Hodgens, Dwight A., Programming and Scheduling Highway Improvements, U. S. Department of Commerce, Bureau of Public Roads, Highway Planning Technical Report, Number 4, April 1966.

18. Hibbard, Thomas H., Applications of Benefit-Cost Analysis: The Selection of "Nonconstruction" Project, Transportation Research Record 490, Washington, D. C., 1974.

19. National Research Council, National Academy of Sciences, Transportation Research Board Special Report 144, July 1972, Issues in Public Transportation.

20. Transportation Research Board, Special Report 146, Washington, D. C., February 1974, Issues in Statewide Transportation Planning.

21. National Cooperative Highway Research Program Synthesis of Highway Practice 6, Washington, D. C., 1970, Principles of Project Scheduling and Monitoring.